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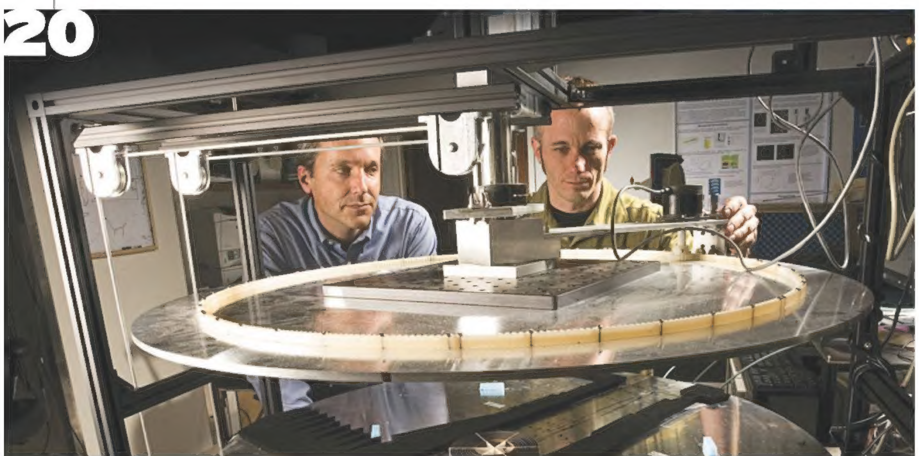

ON THE COVER: In his portrait of the storied racer *Rare Bear* and its crew, photographer Tyson Rininger captures the sense of anticipation that surrounds air races. "Something's coming," this quiet night scene seems to suggest. "Tomorrow, it's win or lose." Story, p. 40.

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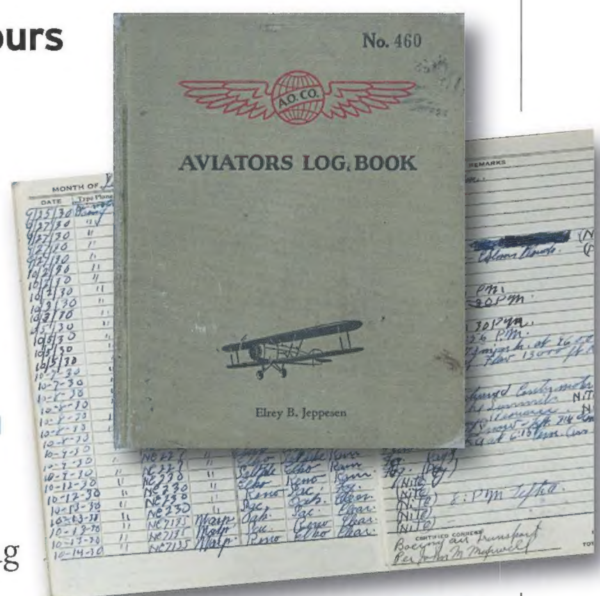

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On the Web Site www.airspacemag.com
Space Station Fly-Around: See what an astronaut sees: every lab, module, and docking port on the 925,000-pound space laboratory in this narrated animation, created by NASA to train spacewalkers.

Viewport

FROM THE DIRECTOR

See the World

TEN YEARS AGO, Bertrand Piccard and Brian Jones made the first nonstop balloon flight around the world. Their March 1999 voyage in the Breitling Orbiter 3 concluded an intense competition—there had been 21 attempts before their success—that had been brewing since the 1970s. Flown on the brink of the 21st century, their 19-day adventure joined a 216-year-old tradition with the marvels of modern technology. And it inspired the two pilots to create something good for the planet they had just circumnavigated.

The first balloon flights, in the 1780s, created a sensation in Europe; enormous crowds gathered to cheer the ascents, and the furnishings and fashions of the time reflect the enthusiasm for flight. At the National Air and Space Museum's Steven F. Udvar-Hazy Center in Virginia, we exhibit a large collection of 18th century consumer goods—chairs with backs carved into the shape of balloons; fans, vases, and textiles decorated with balloon motifs—that demonstrate the excitement people felt about getting off the ground (see In the Museum, June/July 2009). Ballooning awakened a spirit of optimism. We saw the same phenomenon in the 1920s, after Charles Lindbergh's solo transatlantic flight, and again in the 1960s, when spaceflight influenced everything from music to movies. Isn't it interesting that humans reached the moon before they flew around the world in a balloon?

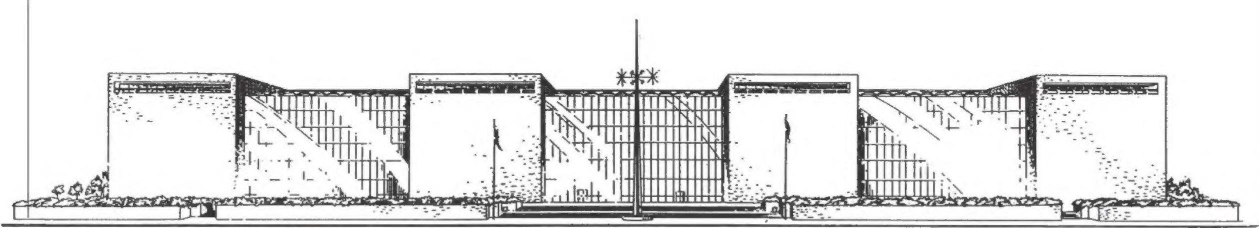
The basic system of dropping ballast to climb and venting gas to descend has not changed since the balloon's invention. Even the design of the Breitling Orbiter 3's envelope, mixing hot air and light gas, dates to the 1780s.

It's the Breitling gondola, displayed in the Museum's Milestones of Flight gallery, that shows how far flight had come since the 18th century. Made of a light but very strong composite of Kevlar and carbon fiber, the gondola was pressurized, as well as equipped with solar panels, rechargeable batteries, and satellite-based navigation equipment. But what made the round-the-world flight possible were advances in meteorology: Much of the time good forecasting enabled the pilots to ride the winds of the jet stream, traveling as fast as 185 mph.

After the Breitling balloonists returned home and had the chance to reflect on their adventure, they spoke about having a changed image of the world, a sentiment often expressed by astronauts, who also get to see the bigger picture. Piccard and Jones used the $1 million prize money to establish a foundation that finances efforts for the early detection and cure of disease among children in Africa. To celebrate the flight's 10th anniversary, the original sponsor, the Breitling watch company, has funded a world tour, featuring a hot-air replica of the Orbiter 3, which Brian Jones is flying to benefit the foundation.

The Breitling gondola reminds Museum visitors of one of aviation's greatest adventures, and now of a great humanitarian cause.

J.R. DAILEY IS THE DIRECTOR OF THE NATIONAL AIR AND SPACE MUSEUM.



See www.airspacemag.com for more about Orbiter 3's birthday.

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Letters

WRITE TO US

Mushrooms, Australia-Style

"Into the Mushroom Cloud" (Aug. 2009) reports on the U.S. Air Force's 4926th Test Squadron. In 1957, I joined the Royal Air Force equivalent, the 76th Special Duties Squadron, which flew sampling missions in modified English Electric Canberra B.6 bombers during the hydrogen bomb tests in Monte Bello Islands, Western Australia, and later at Maralinga Station in South Australia.

For the first detonation, in which I was navigator in the air controller aircraft, Sniff Boss, all aircraft turned away from Ground Zero and kept flying away until the shock wave passed. After that, we turned around to see the Glory of God in front of us. The "fiss ball," as we called the fission reaction, just hovered, broiling away.

Ten miles away, we encountered radiation, which we called "shine" (for "sunshine"). During the early stages of the ball's formation, the twisting white, yellow, red, and green would just melt anything that entered. As the heat dissipated, the colors changed to gray, with the occasional flashes of red and yellow popping out the side. Then the ball rolled into a cloud, which started to rise. At a certain altitude, the center dropped out, creating the stem.

We descended from 45,000 feet to 40,000 and approached the stem, carefully monitoring the radiation instruments and the jet pipe temperatures. Flying past the stem, we were hit by "black rain," and all our instruments lit up like a Christmas tree. We made three cuts through the stem and one peripheral cut into the cloud.

Later, I flew through a 10-megaton hydrogen bomb mushroom cloud as an observer on Sniff One, the prime sampling aircraft. We didn't wear lead or any other protective clothing. But that is another story.

Joseph Pasquini
Royal Air Force (ret.)
Greenwich, Connecticut

Getting Religion Fast

As one of the final generation of jet dead-reckoning navigators (inertial systems weren't introduced until the late 1960s), I don't recall hearing the E6B circular slide rule called "Whiz Wheel" ("The Road to the Future...," Sept. 2009). The term of endearment among us 7 mile/minute (mainly B-47 and B-52) navigators was Prayer Wheel: During our fixing routine, particularly over the pole, the furious pace of manual dead reckoning, aided by the celestial and pressure-pattern navigation required on our complex missions, made prayer an occasional element.

Bill Robinson
via e-mail

That's My Baby

On page 45 of "Martial Arts" (Sept. 2009), the third picture down in the right column shows a variable-sweep-wing supersonic dash design. This is a model of the preliminary design I developed in the early 1960s at Wright-Patterson Air Force Base in Ohio. A drawing of this B-1 forerunner is in *The B-1 Bomber* by William G. Holder.

Thank you for showing that models play as critical a part in aircraft development as admiralty models did in 1700s warship development.

Douglas N. Beatty
Arlington, Virginia

Reader Sigmund Alexander sent in this 1942 postcard showing the St. Petersburg, Florida airport ("The Airport That Wouldn't Die," Aug. 2009).

Letters

Winglet-like

"EZ Does It" ("The Road to the Future...," Sept. 2009) states that Burt Rutan's VariEze was the first aircraft to fly with winglets. Several earlier airplanes used similar concepts, though perhaps not entirely for the same purpose: the McDonnell F-4 Phantom, the North American XB-70 Valkyrie, the BAC TSR-2, and, going back to the early 1940s, the Curtiss-Wright XP-55 Ascender. Many have remarked on the aerodynamic similarities between the VariEze and the Ascender.

Jack Abercrombie
Florissant, Missouri

Disputed Paternity

A letter in the September 2009 issue ("Son of a Lancaster") says that the passenger version of the Lancaster bomber was the Avro Lancastrian, not, as you'd written in "Travels with Churchill" (June/July 2009), the Avro York. You and the letter writer are both right, sort of. The Lancastrian was a variant of the Lancaster airframe, while the York's fuselage was new. Still, the York did utilize the Lancaster's wings, engines, and undercarriage.

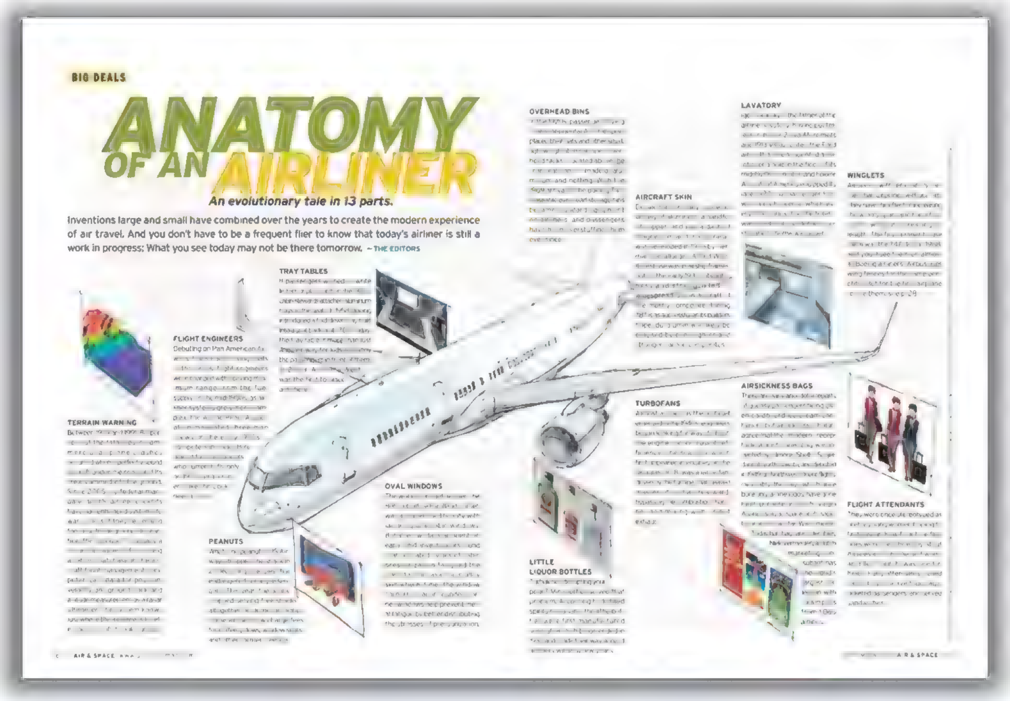
Graeme J.W. Smith
Newport, Rhode Island

Corrections

September 2009 Cover: The Northrop Grumman FB-23 and NG-LRS Subsonic models were printed in reverse (the insignia should be on the left wings).

"Mars, and Step on It": On a trip to Mars, a nuclear thermal rocket would, like a chemical rocket, exhaust its fuel at the beginning of the trip and would not continue to accelerate to the halfway point. Notes NASA propulsion engineer Bill Emrich: "While there is plenty of energy in the uranium fuel to thrust for the entire trip, the hydrogen propellant being heated by the uranium would run out long before the energy available in the uranium is used up."

"Anatomy of an Airliner": We regret omitting the credit for the artwork (below). The artist is Harry Whitver.



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Brian Grote is a flight instructor with years aviation experience. He also writes monthly columns on subjects pertaining to aviation.

FLYBY

ARTICLE WRITTEN BY: BRIAN GROTE

Dear Brian,

I've been flying for over 20 years. My usual run is a Denver departure at 9pm, fly to Billings, on to Cheyenne and then back to Denver by 5am. I fly a King Air 350. I love my career and I pride myself on doing the best job I possibly can.

Last time out, however, I was making lots of little mistakes. I was cleared for the ILS Runway 35R into Denver, but I couldn't pick up ATIS. That's when I looked at my radios and noticed I had dialed in the wrong frequency. I glanced again and dialed in the right frequency. I continued through my checklist and set my Radar Altimeter to 5500 feet. I was ready to make my descent and start my approach. After the outer marker I glanced at my DH again and noticed that I had set my Radar Altimeter, 67 feet low. Luckily, I landed safely, bouncing the wheels just a little.

After a couple more days in the sky I could tell my eyesight was beginning to deteriorate. I knew I wouldn't be able to renew my first class medical if I didn't do anything about it. I was really worried and started asking my peers if there was anything I could do. A co-worker gave me a bottle of Claroxan™ and told me it would help me maintain my depth perception. I was skeptical at first, but tried it anyway. As it turns out, the stuff works great. The problem is, I ran out and don't know where to find more. Have you heard of this Claroxan™ stuff? Is it available in the States?

Jason, 46 – Seattle, WA

Jason,

Not only do I know of Claroxan™, it just so happens I take it everyday. Being a pilot myself, I know that perfect visual acuity is an asset none of us can afford to lose. That's why every pilot should be protecting their eyesight before it's too late.

Claroxan™ contains ingredients proven beneficial for the eyes. Among these ingredients are lutein and zeaxanthin – powerful antioxidants that have been clinically proven to protect the retina and macula and, in some cases, reverse the damaging effects of macular degeneration. These antioxidants block damaging UV rays and halt damaging free radical oxidation in the back of the eyes. They have also been clinically proven to decrease the risk of cataracts.

Claroxan™ also contains bilberry, an antioxidant known to improve night vision. Bilberry's night vision enhancing effects were first noticed in England in the early 1940's. The RAF ordered English fighter pilots to eat bilberry jam on toast figuring it would give them an advantage during night raid missions against the German Luftwaffe fighters.

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Hope this helps!
Brian

THE Himalayan CATARACT project

The Himalayan Cataract Project strives to eradicate preventable and curable blindness in the Himalayas through high-quality ophthalmic care, education, and establishment of a sustainable eye care infrastructure.

Based in Asia, at Kathmandu in Nepal, the Project is empowering local physicians to alleviate the suffering caused by blindness through unique programs including skills-transfer education, cost-recovery, research, and the creation of a world-class network of eye care facilities.

In years past, PacificHealth donated a portion of profits to HCP for development and construction of eye facilities in the Himalayas.

Visit CureBlindness.org to learn more about HCP.

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Devils' Advocates

>>> **"THREE, TWO, ONE,** *now!"* Just seconds ago Asmin "Oz" Pathere was sitting under a beach umbrella in the baking heat, gazing off into the distance—now he has jumped to his feet behind his camera tripod and is on his walkie-talkie with fellow scientist Steve Metzger, who's a couple hundred yards away. At the count of zero, they both trigger their shutters to get a stereo picture of the devil headed our way.

Me, I'm riding shotgun in a pickup truck with a bunch of scientific instruments duct-taped to the roof (a temporary backup—the team normally uses a specially equipped vehicle). In the driver's seat is Matt Balme of the Planetary Science Institute in Tucson, Arizona. He's an expert on dust devils—the little whirlwinds that form in dusty parking lots and ballfields, picking up whatever sand and grit lie in their path. Except that the dust devils here, on this dry lakebed outside Las Vegas, aren't so little.

Which is good.

Balme guns it, and off we race, dodging rocks, ruts, and creosote bushes as he tries to maneuver the truck into the devil's path. At the last second he turns hard and jerks to a stop. The dust devil passes through us, the blast of sand audible against the metal of the truck. We glance down at the dust particle counter and Balme records the number. The other instruments have captured wind speed and direction, atmospheric pressure, humidity, and temperature.

"That was awesome," Balme says. Then we sit back and wait for the next one, just as he and his colleagues have been doing all day, every day, for two weeks. Here at Eldorado Valley, the dust devils, some of which rise hundreds of yards into the pitiless desert sky, form every few minutes.

What sounds like a lark for teenage off-roaders is actually NASA-funded research into an atmospheric phenomenon common on Mars.

PLANETARY SCIENCE INSTITUTE

Planetary researchers are deaf to the siren call of Las Vegas; they prefer to chase dust devils in the nearby desert.

Temperatures there are much colder than in Nevada, of course, and the air is thinner. But no matter—in both settings, it's the temperature differential between the ground and the air that fuels dust devil formation.

Balme and his colleagues want to know the basic physics and meteorology of dust devils, including how much material they pump into the atmosphere. The scientists don't think devils cause the global dust storms that occur frequently on Mars, but they may contribute to the day-to-day dustiness of the atmosphere; that's something the team hopes to determine.

Planetary researchers are good at finding cheap ways to simulate Mars on Earth, and other scientists have tagged along on this trip, including a team from the Open University in Milton Keynes, England (where Balme is also a research fellow), who are testing an ultraviolet sensor intended for Europe's ExoMars rover, scheduled to launch in 2018. It's hot, dusty work, and though Balme admits the driving is fun, he says that after a month in the field, here and in Arizona, he'll be glad to get home.

Then a call comes over the walkie-talkie, and we're off chasing another dust devil. So far that makes something like 500 here at Eldorado alone.

TONY REICHHARDT

Canada Wet

"I DON'T LIKE WHEELS. With wheels you can't land [just] anywhere." That's the philosophy of floatplane pilot Joyce Dunphy, who got her license in 1954. Under a menacing late July sky on Max Ward's dock in Yellowknife, Northwest Territories, Canada, floatplane jockeys gathered to swap stories, party, and picnic at the Midnight Sun Float Plane Fly-in.

The fly-in has been held every two years since 1995. This year, aircraft arrived from Washington state, Tennessee, and across Canada. Gatherings have drawn pilots from as far away as Hawaii.

The approaching weather front has already delayed several floatplanes due in from Manitoba. As a Cessna 172 taxis backward and sideways toward the dock with full flaps, the wind whips up, cups fly off tables, and waves spray the dock.

The floatplane community was always tight, but over beers one summer evening at Yvonne Quick's fishing lodge on Water Lake came the idea to make it official. Quick came here in 1968 to run a flying school; with four other local business leaders, she arranged the first gathering. "It was spectacular," she recalls. "We had about 34 airplanes. Docking was tight."

Most of the floatplanes are Cessnas and Beeches. "But in 2007 an open biplane [1929 Travel Air 4000] came in from Washington state—the fella that flew it up gave rides," says Quick. "It was just the best thing."

At the Saturday picnic on Chedabucto Lake, the fickle summer weather cut short dessert, but Sunday's storytelling tent more than made up for it. Paul Laserich, who flew with his late father Willy, recalled dad's favorite trick to quiet rambunctious huskies in a de Havilland Beaver: A zoom and a zero-G pushover floated the animals to the ceiling. "The dogs would keep strangely silent for a good 45 minutes after that," he recounted. "But it didn't amuse the Inuit keeper in the back with the whip."

GRAHAM CHANDLER

GRAHAM CHANDLER

Max Ward's de Havilland Super Otter takes center stage at the Midnight Sun Float Plane Fly-in at Canada's Yellowknife.

Big Dustup in Little Falls

WHEN LITTLE FALLS, Minnesota mayor Cathy VanRisseghem talks about Charles Lindbergh, she automatically glances at a photograph on the wall that shows a replica of the *Spirit of St. Louis* flying over the town, population 8,100, in 2002, in honor of the aviator's 100th birthday. VanRisseghem was at Lindbergh's childhood home, just south of town and along the banks of the Mississippi, when the aircraft flew over.

"You know at one point Charles Lindbergh had to have flown that plane over that home," she says. "It was awesome to be a part of that history, and the history that was made so many years ago. We're just a continuation of it."

Thanks in part to the efforts of VanRisseghem and other Little Falls citizens, the Charles A. Lindbergh

LEFT: MINNESOTA HISTORICAL SOCIETY; OPPOSITE: NASM (SI-87-15484-P)

When budget cuts threatened to shutter Charles Lindbergh's boyhood home, supporters put smoldering pen to paper in protest.

Esther Dyson

The daughter of physicist and futurist Freeman Dyson, Esther Dyson made her mark as a savvy analyst and investor in Internet startups like the photo storage site Flickr. Lately she has sponsored a series of workshops on the future of private aviation and space travel.

When did your interest in space start?
When I was a kid I figured I would go into space like everybody else by the time I was 40. It became obvious it wasn't going to happen like that, so I started getting interested in the privatization and commercialization of space, the way the Internet had been privatized and commercialized. I started a conference called Flight School and invested in Space Adventures and XCOR.


Esther Dyson preps for spaceflight in Russia.

You recently completed spaceflight training in Moscow. Will you now raise the money for a flight to the space station?
My best chance of going is to make $40 million on my IT investments. Or maybe in 10 years XCOR will have a spacecraft that goes into orbit, as opposed to the suborbital things they're doing now. My next actual flight is going to be on a test run of XCOR's Lynx. I'm an investor, so I get to go. I'm willing to take the risk. I've had a long, happy life.

For the market appeal of space tourism, which is more important: the view of Earth or weightlessness?
You see it pretty clearly in the different approaches of XCOR [Lynx] and Virgin Galactic. Virgin is focused on luxury, floating around in space; with Lynx it's just you and the pilot. It's still not clear if you even get out of the seat. The Virgin experience is to bring your family and pay up. Lynx is like being a macho guy.

The argument has been that private sector investors are too short-sighted, so government has to step in.
Investment *institutions* are short-sighted, but I mean individual billionaires. Look at the Mars Corporation idea: Millions of individual investors put a couple of thousand dollars apiece into a corporation whose purpose is to inhabit Mars, and they get a lottery ticket to Mars. You get this non-nationally bound institution which is a constituency for Mars exploration.

What will be the turning point that will accelerate space enterprise?
Probably when [Elon] Musk has some competition (see "Is It Safe?," Apr./May 2009). Just like you had the Tandy Radio Shack versus the Atari.

Are you a pilot?
I don't even have a driver's license.

Read the complete interview at www.airspacemag.com.

Historic Site remained open to the public this past summer. When the Minnesota Historical Society announced in April that the home and museum would likely be shuttered for economic reasons, residents and others inundated officials with 3,000 letters of appeal, some of which came from Le Bourget, France, Little Falls' sister city, where Lindbergh landed after his 1927 transatlantic flight. "That was far and away the biggest interest generator that we've seen," says state representative Al Doty, who received more than 1,000 letters.

It was a tough decision to nominate the Lindbergh site for closure, but with state funding expected to be cut by $4.8 million, there was little choice, says John Crippen, the society's acting director of historic sites and museums. Lindbergh's was chosen primarily because of its low visitation numbers: About 10,000 annually.

In June, the site got a reprieve: Budget cuts were not as drastic as had been anticipated. Crippen says that the volume of letters made the difference in the state's funding decisions.

Still, money was cut. Hours were reduced and the season will end early. But the site's nine employees still have jobs, and the $1.31 million the facility brings to the community is money in the bank. What happens in the next budget cycle is unknown, but Crippen is confident the site will remain open.

LYNN KEILLOR

SASHA LAVROV

Mock Mach

AT 10 TIMES the speed of sound, nothing will be normal. Take the "big motor/tiny airframe" design of a hypersonic scramjet aircraft, then add the fact that no one has yet gone that fast, and flight at 8,000 mph is not for the timid.

But a team of researchers from Ohio State University and the U.S. Air Force Research Laboratory at Wright-Patterson Air Force Base in Dayton, Ohio, hope a recently developed controller will bring engineers one step closer to a reliable, maneuverable hypersonic aircraft.

"You're operating at such high speeds that if you decide you have to maneuver," says OSU aerospace engineering professor Jack McNamara, "you're going to be way past where you were when you decided you had to move."

McNamara produced one of the most detailed computer models to date of a Mach 10 scramjet aircraft. But at hypersonic speeds, massive aerodynamic forces and friction-induced heating impinged on the aircraft's reactions to control inputs. Since the controller had no way to account for the changes, it would apply corrections that eventually rendered the model unstable.

The OSU-Air Force team turned to Lisa Fiorentini and Andrea Serrani, control systems scientists from the university's department of electrical and computer engineering. Their answer: Allow wiggle room for the unknown.

Fiorentini and Serrani's controller software is adaptive: As long as the attitude, altitude, thrust, and related flight parameters stay within predicted ranges, the controller ignores small changes caused by aerodynamic and thermodynamic distortion. "You don't really care to get exact values," says Fiorentini, "because there is an internal mechanism that adjusts for the uncertainty."

During computer simulations, the adaptive controller kept McNamara's computer model within two feet of its target altitude. The non-adaptive controller, on the other hand, had an average error of about 40 feet.

The researchers were quick to point out that the controller is still a long way from actual flight testing. But that didn't keep Fiorentini from making a modest announcement of the achievement. "I told my mother on the phone; she cried because she was so excited," Fiorentini says.

MATTHEW CUNNINGHAM

A Helicopter in Every Garage

THE PV-2 HELICOPTER was the mechanical equivalent of a Victorian crazy quilt. The fuselage was made from a Curtiss-Wright Junior found abandoned in a Pittsburgh brewery. A Packard from a junkyard contributed an oil pump, a rusted Chevrolet supplied a clutch, and roofing tin covered the rotor mounting. The left landing gear was graced—for no apparent reason—with a car horn.

The brains behind the contraption was the P-V Engineering Forum, founded in 1940 by engineers Frank Piasecki and Harold Venzie, along with a few of their former college classmates. The Philadelphia-based organization had planned to develop appliances such as vacuum cleaners and washing machines, but in a burst of confidence decided instead to design a helicopter. But not just any helicopter. The engineers wanted to create the aerial equivalent of the family sedan.

"Any intelligent person who can learn to drive a car will be able to fly a postwar helicopter after a few easy lessons," Frank Piasecki confidently told the *Los Angeles Times* in 1944. Piasecki's PV-2 in test flight, above, and on display at the Museum's Steven F. Udvar-Hazy Center, top.

By April 11, 1943, the group was ready to conduct the first tethered tests of the PV-2. Because they were unable to afford a test pilot, Piasecki volunteered to sit in the experimental aircraft himself, even though he did not have a pilot's license.

"Unfortunately," says Roger Connor, the National Air and Space Museum's curator of vertical flight, "they hadn't bothered to hold it down with anything better than clothesline, which broke." As tethered test changed abruptly into free flight, Piasecki managed to control the runaway helicopter and land it safely—impressive for someone who had a mere 14 hours of flying time, all in a Piper Cub.

Piasecki had been trying to interest the U.S. military in the PV-2 for more than a year, even though a single-seat design had few useful applications. But in the fall of 1943, after a Senate investigation forced the U.S. Navy to search for a new helicopter, the forum gave the aircraft a smarter look by covering its bare fuselage with doped muslin sheets painted maroon and silver, and headed to Washington, D.C., for an exhibition flight.

Renting a flatbed truck to transport the helicopter was out of the question; the company had run out of money. So Piasecki hitched the tail of the PV-2 to a Pontiac and towed it the 135 miles from Philadelphia. "Its wheels didn't have bearings," says Connor, "so they rapidly heated up after a few minutes of travel at even fairly slow speeds, and Piasecki had to stop frequently

TOP: DANE PENLAND; BOTTOM: NASM (9A00979~P)

and throw water on them from any handy roadside ditch. On one occasion, a ditch wasn't handy, so Piasecki hopped a fence in a cow pasture to get to a pond, but had to deal with an angry bull."

After the adventure of getting the PV-2 to Washington, demonstrating it to the U.S. military was a breeze. On October 13, 1943, wearing his trademark Homburg and bow tie, Piasecki completed several exhibition flights. In an added flourish at the end of the performance, a Civil Aeronautics Administration inspector presented Piasecki with a helicopter license—the first granted to someone who didn't already have a fixed-wing license.

The *Christian Science Monitor* reported that the display was a success: "Demonstrations before military officials have aroused interest in possible war use for helicopters. P-V is working on a helicopter with a pay load of more than one ton and a range of 400 miles, for possible use for military rescue work, liaison, invasion, antisub activity, and other war purposes."

The next day, Piasecki invited film photographers to meet him in northern Virginia, to show off the PV-2's potential in the civil market. The resulting newsreel segment, *An Air Flivver in Every Garage*, showed Piasecki backing the PV-2 out of a garage, topping off at a nearby gas station, then flying to a golf course for a few rounds. (The film needed some creative editing, since the PV-2 couldn't hold both a pilot and a golf bag.)

The newsreel was wildly popular, bringing investors to the company and paving the way for Piasecki to become the premier maker of transport helicopters. On January 1, 1944, the forum received a Navy contract for the XHRP-X Dogship, the world's first successful tandem-rotor helicopter (which went into production as the HRP-1).

Having aptly demonstrated the company's ability to design a practical helicopter, the PV-2 was basically retired, flown occasionally on company anniversaries and important milestones. On July 6, 1965, Piasecki donated the PV-2 to the National Air and Space Museum; it's now on display at the Museum's Steven F. Udvar-Hazy Center in northern Virginia.

REBECCA MAKSEL

Visitor Information

Star Party Join Museum astronomer Sean O'Brien on Saturday, October 10, from 6:30 to 10 p.m., in observing celestial objects in skies unpolluted by city lights. Sky Meadows State Park, Virginia. Parking fee: $4 per car. Park phone: (540) 592-3556.

What's Up Receive regular updates on Museum events, read about artifacts, get detailed (and behind-the-scenes) exhibition information, and receive calendar listings, all by subscribing to the National Air and Space Museum's free monthly e-newsletter, *What's Up*. Sign up at *www.nasm.si.edu*.

Museum Lecture The culminating event of the year-long National Air and Space Museum observance of the Centennial of Military Aviation will be an evening symposium on the 1909 Wright Military Flyer. Hear several of the world's experts speak about the aircraft on Wednesday, October 7, at 7:30 p.m. in the Lockheed Martin Imax Theater in the Museum on the National Mall. Tickets are free but must be requested; for more information visit the Museum's Web site at *www.nasm.si.edu/events*.

ARTIFACTS

A Telescope for the People

THE NATIONAL MALL HAS ITS MONUMENTS, but what it needs, says David DeVorkin, is a portal to the universe. DeVorkin, a curator in the space history division of the National Air and Space Museum, has long fantasized about turning one of the National Mall's many domes into an observatory. And while Washington rooftops have been spared, fantasy is about to become reality as the Museum – in celebration of the International Year of Astronomy and in honor of the 400th anniversary of Galileo's use of a telescope – builds the National Mall's first observatory. When it opens later this year on the Museum's east terrace, visitors will have four hours a day to view the sun, moon, and the brighter planets, weather permitting.

Nice view: A 16-inch Boller & Chivens telescope, borrowed from Harvard, will be installed within a 22-foot-high observatory on the Museum's east terrace.

MATTHEW BREITBART

Canadian Helicopter Force, Afghanistan

THIS IS THE SIXTH RAMP ceremony I have attended. This time Canada lost three soldiers. They had completed a mission to defuse another improvised explosive device and were on their way back to base when a massive roadside bomb destroyed their armored personnel carrier.

After the ceremony, I head back to my shelter in the Canadian Air Wing lines at Kandahar Airfield in Afghanistan. I go to bed, close my eyes, and think about the men who died. Two were relatively young; the other was 38, a seasoned soldier and father of four. Eventually I doze off, with nightmares of what my fellow soldiers' last moments must have been like.

I awake in a cold sweat and bolt upright. Turbine engines whine as a large aircraft a few hundred yards away struggles into a steep departure. A siren sounds and a British-accented voice announces, "Rocket attack, rocket attack, rocket attack." I check that all my arms and legs are still attached. I must have been awakened by the impact of yet another rocket from the surrounding insurgents.

I lie back down so that all of me is below the concrete barriers that surround the shelter. I reach under my bed, fumble for my flak vest and helmet, and suit up while lying flat. I try to go back to sleep; I have another big day tomorrow.

I command the Chinook Flight of the Canadian Helicopter Force Afghanistan, Canada's first expeditionary force with helicopters in a combat theater. We previously had Chinook C models, but those were sold to the Dutch. Since 1993, Canada's army aviation fleet has consisted of only the light utility/reconnaissance Bell 412 Griffon.

Since January 2002, Canada has contributed a significant number of boots on the ground to the war in Afghanistan, but without any helicopter support. We desperately needed armed helicopters, but more importantly, medium- to heavy-lift support to get our men and women off the dangerous Afghanistan roads. The Canadian government bought from the U.S. Army six D-model Chinooks already in service in Afghanistan. In March 2008, a few of us were sent to Alabama so the U.S. Army could train us in flying the Chinook D. By October we were in theater, and in late December we took possession of our Ds, now with the type designation CH-147. We started flying combat missions almost immediately.

The day after the nighttime rocket attack, I had an early morning start with mission briefings, and shortly thereafter we were out the door to move passengers and equipment between Kandahar and various forward operating bases. I was the air mission commander for two Chinooks, escorted by four armed Griffons. The plan was to move 200 Canadian soldiers, who for two days had been conducting operations against the insurgents, from a remote location to their secure base.

After breakfast, we were briefed that another Canadian company had just struck a roadside bomb and lost three soldiers, and had several wounded. The casualties had been extracted, but the company commander had requested Chinooks to pick up the remaining company members and fly them back to their base, lest they detonate more bombs on the drive back.

Arriving at the release point in the desert, several miles south of the landing zone, I was advised that the LZ was taking enemy fire. When the all-clear came, and we were 30 seconds out, the ground forces popped colored smoke. The LZ was clear—to both me and the enemy. We came in fast and I

Comrades carry the body of a Canadian soldier during a ramp ceremony. The author attended such ceremonies for 20 soldiers during his six-month deployment.

stood the helicopter on its hind legs to brake our speed as quickly as possible. When the aft wheels touched down in a muddy poppy field, Jake, my lead flight engineer, lowered the ramp. Within 30 seconds a bus-load of soldiers ran aboard. Jake raised the ramp, and I snapped us back up.

While my first officer, Jay, was flying, I looked back into the cabin. Tired and dirty soldiers were hunkered down, all with big smiles of relief. There is no certificate or medal that can compare to that moment.

The emergency evacuation done, we returned to Kandahar and took on fuel with the engines running. During the next several hours, we moved a couple of hundred people and tons of equipment in and out of bases.

The biggest lesson for the day was getting a feel for the relatively massive downwash the Chinook dual rotor system produced; with a diameter of 60 feet, each rotor disc pushes a storm of air to the ground. I lost count of the boards, chairs, and tents we blew over that day. My biggest concern was the number of outhouses we knocked over. No one was inside them—I hope.

When a helicopter lands in a sandy environment, the downwash generates a dust cloud that envelops the helicopter like a cocoon and blinds the pilots. In the CH-147D, there are no special instruments to guide the pilot to the ground, other than your own Mark I eyeball. Night landings are even more challenging; night-vision goggles restrict your field of view. Imagine driving at night in thick snow with toilet-paper tubes taped to your eyes. The art comes in finessing your approach path to eliminate sideways drift and keep the descent rate relatively slow but brisk. It was a balancing act, made worse by the weight of a full load of troops—the heavier the aircraft, the denser the dust ball. But whatever the aviator does, before the tires touch the ground, the surroundings will "brown out"—you lose all visual cues. At that point, it's like watching a toilet overflow; there is nothing to do but stand back, watch it happen, and hope for the best.

Finally, we were back at Kandahar, and we shut down the engines. The rotors slowed to a stop, and I peeled off my helmet, which had not left my head for the better part of the day. Like a contortionist, I moved my arms and legs in all directions, and used all my remaining strength to extract myself and my 50-odd pounds of body armor and survival equipment from the cramped Chinook cockpit. I just wanted to eat supper and go to bed, but I still had to sign in the aircraft and complete mission reports. After that, I would attack the pile of flight commander e-mails and attend a meeting or two, or three. The flight engineers and gunners had yet to put the aircraft to bed and clean weapons.

The next day, I had a new crew and the mission was resupply, including a stop to pick up a load for delivery to a partner country's team at an austere location. The load weighed several thousand pounds, or so my operations staff said. When we arrived, the load was in crates wrapped in a cargo net. A three-man rigging team stood on top of the load, ready to fasten it to the hooks on the belly of the helicopter.

I was flying with Fred; it was his first flight since returning from leave in Canada. My flight engineers, Chris and Ray, also just back from leave, connected us to the load. With great precision, the trio brought our Chinook over the load, just two feet above the riggers' heads. The load was hooked, the riggers moved off, and as the helicopter lifted the load 10 feet off the ground, we felt the entire craft strain. (I call it the "bending banana" effect: While the twin rotors pull toward the sky, gravity pulls the load toward the ground.) I checked the engine power we were demanding to ensure we would have enough reserve power to clear the 7,000-foot mountains ahead and get the load to its destination. The load was way over our all-up weight limits. Frustrated at the user's effort to stow a little extra in the package, I directed Fred to put the helicopter down and order the riggers to get their forklift and offload the extra weight. We then took off to the drop-off point with our armed Griffon escort helicopters.

When we arrived at the landing zone, friendly forces were engaged in a firefight with insurgents south of our position. Because we were relatively heavy, our engine performance was limited and we were restricted to gentle maneuvering. As we deposited the load, one of the Griffons zoomed past us. I was thankful it was there, with its twin guns.

A siren sounds and a British-accented voice announces, "Rocket attack, rocket attack." I must have been awakened by the impact of another rocket from the surrounding insurgents.

My crew and I logged another full day of flying time. I finished the night at my desk again. At least I could sleep in: The next day I was switching to a night flying program, moving soldiers to yet another austere location.

When we arrived in Kandahar, I had no office or even a computer. We lacked aircraft, policies, and directives. When the aircraft arrived, we had to teach ourselves its avionics, how to land in brown-outs, and how to sling complex loads. We wrote tactics, standard operating procedures, and a host of other directives. During my tour, Canadian Chinooks safely transported 5,000 passengers and 250,000 pounds of equipment.

I left Afghanistan in mid-April, knowing that other soldiers are going home to their families because we got them off the perilous roads. I'm proud of Chinook Flight. But I will never forget the ramp ceremonies for the 20 Canadian soldiers who died during my deployment, most of them killed by roadside bombs.

MAJOR JONATHAN KNAUL
A/OC CHINOOK, CANADIAN HELICOPTER FORCE, AFGHANISTAN

OPPOSITE: CANADIAN FORCES COMBAT CAMERA

Blown Away

WHEN JET ENGINES CAME INTO widespread use, in the 1950s, engineers pondered the high-energy exhaust they produced. If it could be ducted and blown over the wing, the increased airflow would increase lift. With more lift, wings could be smaller, which enabled higher speeds, and with a blown wing there would be enough lift to support the slow speeds military aircraft needed to land on unimproved runways and aircraft carriers.

Employed since 1956 by the Ball Corporation, manufacturer of glass canning jars, Otto E. "Pete" Bartoe was named company president in 1969. A gifted engineer with a practical bent, he convinced Ball to finance a spinoff company to explore his ideas about a blown wing. In 1973, the Ball-Bartoe Aircraft Corporation was formed in Boulder, Colorado. Over the next four years, Bartoe produced more than 200 engineering drawings, which Brad Davenport ("a master mechanic and an amazingly productive worker," says Bartoe) and Sig Williams turned into the experimental Ball-Bartoe Jetwing.

A Pratt & Whitney JT15D-1 turbofan was mounted in the nose, well ahead of the cockpit and wing. The hot airstream exited the engine core, entered a bifurcated duct, and exhausted just outside the fuselage through slots in the top skins of both wings. Air from the fan was directed aft by vanes in the duct and ducted farther out through slots on the leading edges. About 70 percent of the wingspan was bathed in the exhaust stream.

Mounted inches above the main wing was an "augmentor," a small wing; exhaust gases passed through a slot between the two. A phenomenon Bartoe calls "supercirculation" caused the lower pressure in the slot to draw in more air and increase lift. At the trailing edge, large flaps rotated and extended up to 52 degrees. They remained in contact with the top skin and made use of the Coanda effect, in which airflow bends to follow a curved surface. With the flaps down, the "bend" in the airstream provided downward thrust and enabled the Jetwing to fly as slow as 40 mph.

The Jetwing first flew in 1977, at Mojave, California, with Lockheed test pilot Harold "Fish" Salmon at the controls. The blown-wing configuration generated more than twice the lift of a conventional wing of the same area. The Jetwing flew slowly enough that Bartoe could use his Super Cub as a chase plane.

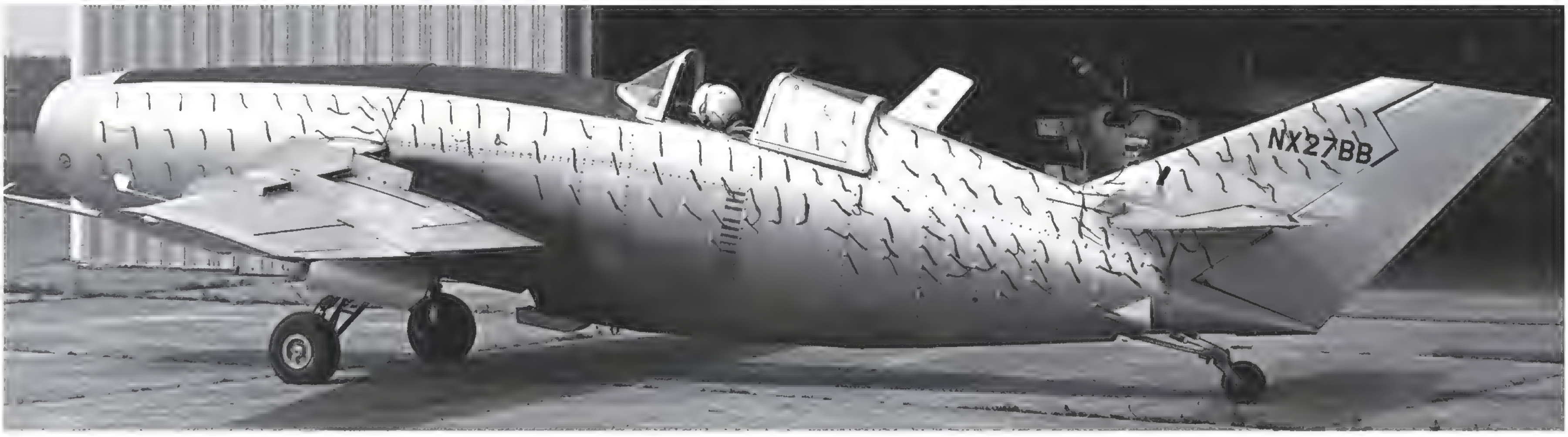
After Salmon completed the initial testing, Bartoe flew the Jetwing back to Boulder. The 106-gallon fuel tank allowed only 40-minute flights, so the trip required 11 refueling stops. Because many of the airports Bartoe used carried only gasoline, a pickup truck carrying jet fuel followed him.

"It was fun to fly," Bartoe recalls. "It was extremely quiet. As long as the engine was running, you couldn't stall it. Landings were interesting: The jet blast came off the deployed flap, bounced off the ground, and forced the tail up. If you reduced power, the tail would come down suddenly, just as the wing was losing lift. But everything happened at such a slow forward speed that it was manageable."

In a Navy program, the Jetwing landed in a mere 300 feet—this from an airplane that could reach 350 mph.

The Jetwing was the only aircraft that used the blown wing for propulsion as well as lift, but in the 1950s and '60s many designers experimented with blown flaps. Currently displayed at the Wings Over the Rockies Air and Space Museum in Denver, Colorado, the Jetwing remains the world's only blown-wing tailwheel jet aircraft.

KEN SCOTT



Tufts on the Jetwing fuselage and vertical stabilizer would reveal airflow patterns.

NASM (SI-2007-1636~A)

LOOK DOWN a long stretch of highway on a summer afternoon and in the distance a pool of water seems to wait for you, glistening under the hot sun. It's only an illusion—Mother Nature's version of a practical joke. The difference in density between the asphalt-heated air near the surface and the cooler air above acts like a lens, bending light waves as they pass from one layer to the next to reflect the blue sky and hide both the blacktop and any vehicles at the far end of the road behind a shimmering curtain.

by Damond Benningfield

Scientists and engineers are trying to emulate that trick by designing materials that could constitute the next-next (or next-next-next) generation of stealth. Some of their ideas sound like they sprang from the imaginations of Gene Roddenberry or J.K. Rowling, with phrases like "cloaking device" and "invisibility carpet" popping up as frequently in academic papers as in television scripts and books for kids. Other ideas are more realistic, as researchers devise ways to change an aircraft's color and blur its outline, confusing the bad guys enough to make them shoot in the wrong direction.

"If someone would have asked me three or four years ago, I would have said there's no science in this—it's all sci-fi," says Vladimir Shalaev, a professor of electrical and computer engineering at Indiana's Purdue University and leader of a group that has designed a microscopic cloaking device. "It's still very challenging, but it's a huge, huge breakthrough to realize that light can behave in such unusual ways that, with certain limitations, objects could become invisible."

Not an entire bomber or fighter, mind you—not for a long time, anyway. While researchers have built small cloaking devices in the laboratory and designed others on computers, light is still too tricky for the whole spectrum of colors to be controlled at once.

"You have to choose the frequencies—the bands over which you're going to be stealthy," says David Carroll, director of the Center for Nanotechnology at Wake Forest University in North Carolina. "An aircraft or a car or other vehicle can have signatures on many, many different levels. Sometimes the signatures are in the infrared, because the object is hot. Sometimes they are signatures in the visible, because you can see it. Sometimes they are sound signatures, like an M1 tank—you can hear it."

Over the years, aircraft designers have experimented with ways to mask all of these signatures. The ideas have made modern-day fighters and bombers prac-

ABOVE & OPPOSITE: © DUKE PHOTOGRAPHY WWW.DUKEPHOTO.DUKE.EDU

Now You See It, Now You Don't

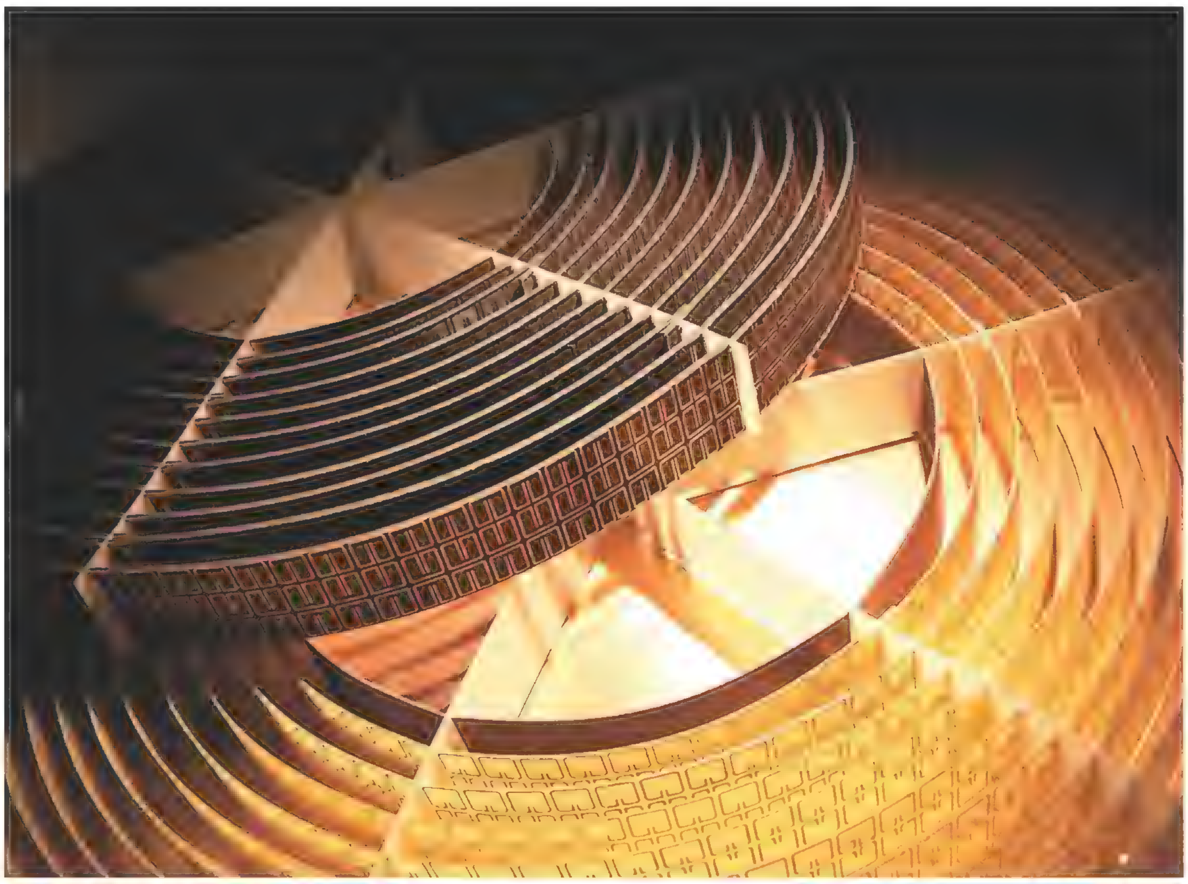
Can science make aircraft invisible?

tically disappear from radar screens, chilled their hot exhaust gases, and even muffled the growl of their engines. So far, though, the most effective way of shielding aircraft from enemy fire has been to camouflage them by painting them black and flying them at night.

Future stealth is also based on camouflage, through agile coloration—a chameleon-like paint that senses the surrounding environment and changes its color to blend in. "It will sense where the sky is, what the color of the sky is, what the contrast is, and then change its own appearance by feeding back into itself, like a chameleon would do," says Carroll. "These smart coatings don't add a great deal of weight to the aircraft. So I think we'll see, probably in the next 20 years, airplanes that change color."

The agile paints that Carroll's group and others are studying are based on electrochromic materials, which change color when an electric charge passes through them. Such materials are already in everyday use. In the rearview mirrors of many cars, for example, an electrochromic compound is sandwiched between layers of glass to prevent bright headlights from dazzling a driver. As the headlights shine on the mirror, they create an electric charge that darkens the electrochromic layer. Carroll's agile paints contain microscopic particles of silver, which grab or lose electrons as an electric current flows past; as the paint's electric charge is altered, its color changes.

A related technology could blur the



Opposite: Duke University's Steven Cummer (left) and David Schurig of North Carolina State University prepare to test a cloaking device by bombarding it with microwaves. Right: The devices are made of copper rings, each surrounded by 10 layers of meta-material.

© WFU/KEN BENNETT (2)

edges of an aircraft, making it harder for a person on the ground to precisely plot its position. Researchers jokingly call it the Predator Effect—named not for the drone aircraft, but for the creature from the movie *Predator*. As the being swung through the jungles of Central America, it bedeviled commandos by turning almost invisible. The creature was transparent, its outline faintly visible, making it almost impossible for the commandos to attack it.

Researchers are examining ways to blur an aircraft's outline by using a recently created branch of nanotechnology known as meta-materials. Ordinary metals, plastics, and other materials are combined in a way that alters their response to light, heat, radio waves, and other forms of electromagnetic radiation. In particular, researchers discovered that meta-materials can bend light in ways that no naturally occurring material can do—even backward. It's that ability that could allow a coating of meta-materials to smear an airplane's outline.

The effectiveness of meta-materials depends on their ability to manipulate a property of matter known as the refractive index, which is a measure of how much a beam of electromagnetic radiation bends when passing from one medium into another, such as from air to water. If you look at a straw in a glass of water, for example, the part of the straw in the water looks like it's bent at a different angle from the part in the air, and it looks closer to you than it really is. That's because when a beam of light crosses the boundary between two materials with different refractive indexes, the beam changes speed and direction. The greater the difference in the refractive indexes of the two materials, the greater the change in speed and direction. This property is what makes eyeglass lenses work. As light passing through the air strikes the surface of a lens, it is bent to a new path; if the lens is shaped properly, all of the light rays come to focus at a desired point in the eyes.

Researchers realized that meta-materials could act as superlenses by drastically altering the paths of light, microwaves, and other forms of electromagnetic energy. At their extreme, meta-materials, which consist of tiny bits of specially shaped metals layered with plastics or other materials that are poor conductors of electricity, can have a negative index of refraction, which means they can bend light so that it travels backward.

Wake Forest University's David Carroll examines two meta-materials (above and right) capable of bending infrared light backward. A magnification of the material above (seen on Carroll's computer monitor) shows that the seemingly flat surface is highly pitted.

In a 2006 paper published in the journal *Science*, Scottish physicist John Pendry and two collaborators at Duke University in North Carolina suggested a dramatic possibility for such materials: cloaking. By manipulating the properties of light, "these fields can be focused as required or made to avoid objects and flow around them like a fluid, returning undisturbed to their original trajectories," Pendry wrote. In other words, a meta-material object could bend the light from the background around to the front, so the object itself would be hidden in an electromagnetic cloak.

Steven Cummer, a Duke electrical and computer engineering professor, is part of the meta-materials research team that built and tested a cloaking device prototype in 2006. It consists of a copper ring surrounded by a shell of 10 layers of a meta-material in which precisely shaped copper patterns are imprinted on a layer of non-conducting material, in this case fiberglass. The team fired a beam of microwaves at the cloaking device and measured both the beam's reflection and the microwave "shadow" the device cast. Each layer of shell bent the beam at a slightly different angle, curving it completely around the five-inch test ring. The result? The copper ring—and the cloaking device itself—was completely hidden.

"The shell took the electromagnetic energy and smoothly bent it around [the copper ring] in the interior, and then bent it back to fill in the shadow region [the space behind the object being cloaked]," says Cummer. "Those are the two things that dictate making something invisible. If you can fill in the shadow and get rid

To see video of a prototype cloaking device, visit www.airspacemag.com.

of the reflection, that's what it takes."

While the experiment proved that meta-materials could cloak an object, it was only a small-scale demonstration. What's more, it was limited to microwaves, which are the type of radio waves used in radar. Cloaking an object in visible light is much tougher, because there is a relationship between the length of the wave to be deflected and the size of the individual elements in the cloaking device: the smaller the wavelength, the smaller the elements of the meta-materials must be. Microwaves are thousands of times longer than waves of visible light, so a visible-light cloak requires meta-material components that are as small as a few millionths of an inch across. And even if such tiny structures could be manufactured, the metal in them would absorb light waves more efficiently than microwaves, so less of the light would be deflected around the object.

Yet Purdue's Shalaev says that cloaking an object in visible light is not impossible. In 2007, his group designed a visible-light cloaking device. Like the Duke experiment, it consisted of a central ring encircled by meta-materials. In this case, though, instead of a shell of concentric rings, the meta-material consists of tiny wires that radiate from the central ring like the bristles of a round hairbrush. In theory, Shalaev says, the device would deflect light around the ring, making it completely hidden from view. "You create an area where light cannot enter, and it flows around that area in such a way that it looks like nothing is there—like empty space," he says.

There are problems with the design, though. First, because different wavelengths of light are refracted at different angles (which is why shining a beam of light through a glass prism creates a rainbow), the cloak is limited to a single wavelength—in this case, red. And second, Shalaev and his team have not yet met the technical challenges required to build the device.

Even so, Shalaev says they have already thought about ways to build a broader cloak to cover a wider spectrum of colors. "The idea is that there are several cloaks hidden one inside of the other, and each of them works for its own wavelength," he says. To explain the concept, he conjures an image from his native Russia: "It's kind of like a *matryoshka*, where one doll is sitting inside of another doll."

Unfortunately, each doll adds weight. "This is mathematically pretty simple, and you could put it on an airplane and your airplane would disappear, but only at the narrow frequency of your cloak," says Carroll. "So if I have an F-22, and I want to make it disappear to the visible range, I'm going to have to have a lot of layers. The material that we're talking about is almost solid metal, which means I just added a ton to the airframe, and that's not going to work very well."

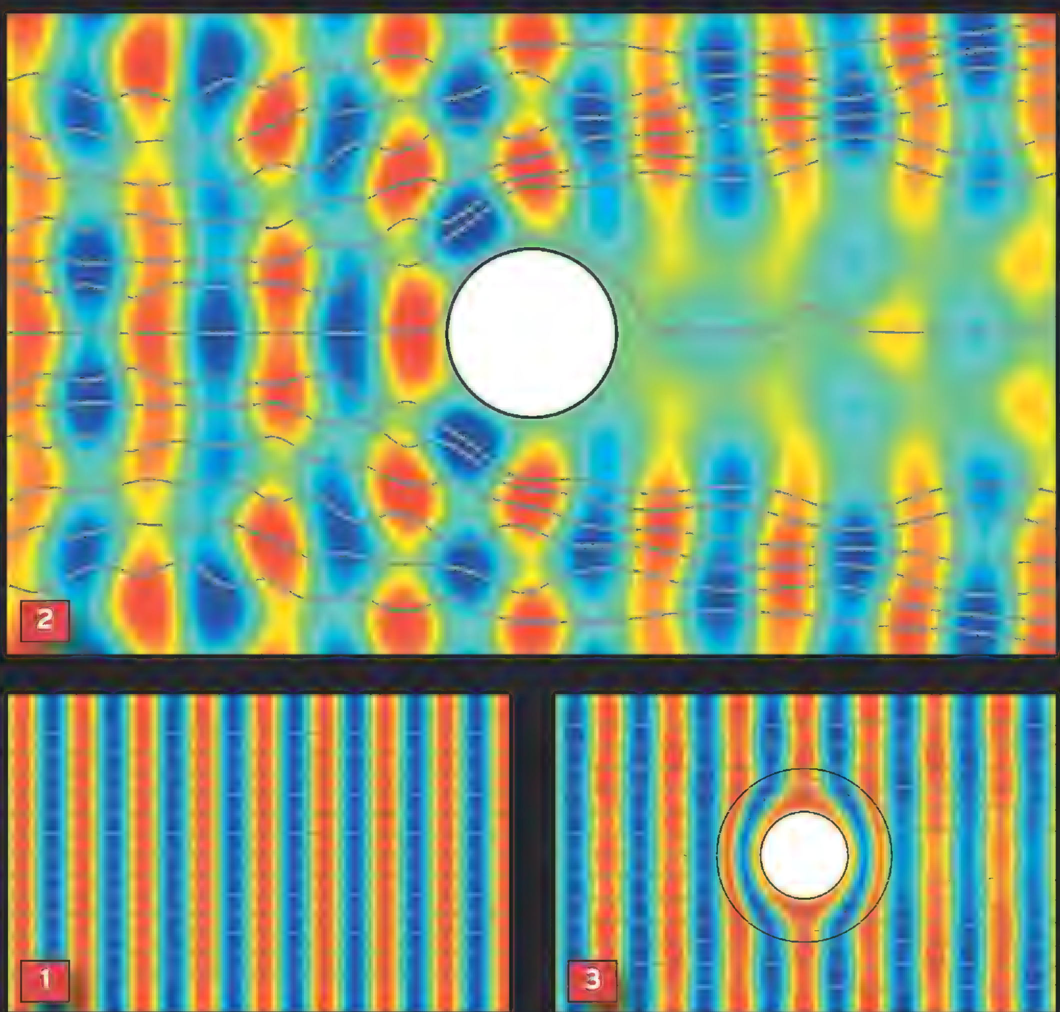
But if cloaking won't work in three dimensions, perhaps it will work in two.

In January, Duke researchers reported a successful test of an invisibility "carpet." They placed a meta-material cloak atop a reflective metal surface with a significant bump protruding from the otherwise flat surface. When the researchers aimed a microwave beam at the test rig, the bump was hidden—the microwaves behaved as if they reflected directly off of a flat, bump-free surface beneath the cloak.

While the test cloak was carefully shaped to minimize its own microwave reflection and shadow, the researchers suggested that the technique eventually could be used to hide objects from detection in both microwaves and visible light. "In essence, you're hiding the bump by masking it with the cloaking layer, and making the combination of the cloak and the bumpy surface look like a flat surface," says Cummer, who did not participate in the test.

Cloaking an entire airplane may never happen, at least not with the materials and techniques currently under development. Yet advances in meta-materials may yield smaller applications that could keep pilots and their aircraft safer and improve life for the rest of us: shielding electronics against lasers, microwaves, and other forms of radiation, coating adjacent radio towers so their signals don't interfere with one another, developing computer circuits that switch on and off by using light waves instead of electricity, and many others.

It's not exactly Harry Potter's cloak, but it's no mirage either.



The gray lines in image 1 represent electromagnetic energy flowing unimpeded. In the second image, the waves of energy scatter around a solid object, creating a shadow to the right of the object. With Duke's cloaking device (image 3), the energy waves do not bounce off the object, making it undetectable.

STEVEN A. CUMMER/DUKE UNIVERSITY

Sweet 17

WHO DOESN'T HAVE A CRUSH ON THE BEECH STAGGERWING? BY JAMES WYNBRANDT

PHOTOGRAPHS BY ARNOLD GREENWELL

Every October, the Beechcraft Heritage Museum in Tullahoma, Tennessee, calls Staggerwings back; in their D17F, Alan and Patty Russell heed the call.

In 1973, REPRESENTATIVES OF THE STAGGERWING CLUB approached Beech Aircraft chairwoman Olive Ann Beech with a plan: They wanted to create a museum dedicated to her company's Model 17 Staggerwing, an iconic 1930s high-end biplane. But the reception they got was barely cordial.

"Mrs. Beech said, 'I don't like museums, number one, and number two, museums like this are started by people with big ideas and small pocketbooks without management skills, and a few years after they start, they run out of enthusiasm,' " recalls John Parish Sr.

"We said, 'Mrs. Beech, we're not asking for anything except your blessing, because we have such high respect for the standards that Beechcraft represents. And hopefully one day we'll prove to you that we're going to do this right.' "

Mrs. Beech might have been more receptive had she known that the idea had come from a pilot who flew a C17R Staggerwing to victory in the 1936 Bendix race—Louise Thaden, the race's first female winner and one of Mrs. Beech's acquaintances.

In 1973, the Staggerwing Club had held an event at which Thaden was the guest speaker. "She said the airplane was ahead of its time and that something ought to be done to commemorate it," recalls antique aircraft enthusiast George Schulz.

NASM (83-2087)

Bulbous Staggerwing noses frame visitors at the annual Beech party (above). Right: Louise Thaden (left, with Blanche Noyes and Vincent Bendix), who won the 1936 Bendix race in a Model C17R, was the first to propose a museum.

The Model 18 (above), another star in the Beech firmament, was first invited to the museum fly-in in the mid-1990s. Beech Fact no. 17: A Staggerwing always draws a crowd (left).

"The club sat up and said, 'Yeah, let's start a museum!' "

It's early afternoon on day two of the four-day Beech Party, held each October at the Beechcraft Heritage Museum, located at Tennessee's Tullahoma Regional Airport. Pilots are preparing to fly their Staggerwings around the pattern in formations of twos and threes and make low passes down the runway—preferably carrying visitors who have only dreamed of flying in a Staggerwing. A chorus of Jacobs and Wright radial engines rises in the background as Bud Fuchs, a Staggerwing check pilot from Cape Coral, Florida, preflights a yellow 1938 F17D and recounts his introduction to the fraternity 25 years ago.

"I owned a Beech Travel Air twin"—a predecessor of the Beech Baron—"and we heard there was some kind of fly-in here," Fuchs says. "We flew over and saw all these Staggerwings lined up on the field, and we landed...." He fast-forwards the story: "I sold the

Travel Air and bought a Staggerwing in pieces."

Among biplane aficionados, the Staggerwing Swoon is fairly common, and nearly every Model 17 fan can tell a Staggerwing-in-pieces story. Several aircraft in the museum and on the flightline were resurrected from derelicts, wrecks, and collections of parts. Ron and Mark Morrison, now from the Chicago area, spent years as teenagers rebuilding a silver 1938 F17D Staggerwing with their father. Shortly after their father's death, the aircraft was badly burned in a hangar fire, and they spent years rebuilding it again.

The Staggerwing is not just a pretty face, Fuchs notes. "It's an antique, it's a classic, it's a warbird—some of them were military—it's a tailwheel, it's a round engine, it's a biplane, and they'll also fly five people three miles a minute."

Les Grotpeter of Creve Coeur, Missouri, had to sell his Staggerwing in the 1970s, leaving him with only a photograph to remember it by. "For the next 18 years I looked at the picture every morning when I got up and said, 'Someday I'll have another one.'"

The opportunity came after a bout of cancer 15 years ago. "The minister came to see me in the hospital and said, 'You know, the cancer might come back, so when you get out of here, buy something that you've always wanted.' And that's what I did." He bought a 1943 Staggerwing D17S.

IN THE EARLY 1930S, Walter Beech decided the world needed an executive aircraft with exceptional performance. At the time, he was working for Curtiss-Wright; when the company passed on the project, he quit to found Beech Aircraft Company in Wichita, Kansas, with his wife, Olive Ann, and an engineer/designer, Ted Wells, in 1932. The Model 17, the company's first product, introduced to general aviation such innovations as retractable landing gear, seats with built-in parachutes, and, most distinctively, the negative stagger—the upper wing set aft of the lower wing, the opposite of the standard biplane configuration. The design offered outstanding visibility through the unobstructed windscreen, and gentler stalls: the lower wing stalls first, while the ailerons on the unstalled top wing remain effective; the nose drops, and airspeed increases. Staggerwings were works of art, custom-made with interiors of polished woods and rich leathers, and were priced accordingly: $18,000 at a time when Stinsons and Wacos were fetching a third of that. According to lore, its original name, the Stagger Beech, was overwritten when admirers chose to call it Staggerwing.

The unique planes and curves of the sculptured Model 17 have attracted aviation photographers since the aircraft debuted in 1932.

In 1951, the U.S. Air Force established the Arnold Engineering Development Center at Arnold Air Force Base in Tullahoma. Still the world's largest complex of flight simulation test facilities, the center drew civilian engineers and technicians to the bucolic area, some with an interest in aviation beyond career motivations. By the mid-1960s, the Tullahoma airport had become a second home to several of them.

"We had about a dozen people, and just some old airplanes," says George Schulz, then a propulsion engineer at the Arnold Center.

They flew Meyers OTW biplanes, Fairchild PT-19s and -23s, Cessnas, and Pipers. John Parish's family owned former dairy farm property adjacent to the airport, and Parish invited friends to keep their airplanes in his hangars, dubbed the Parish Aerodrome. The group began traveling en masse to regional fly-ins.

"There'd be eight or nine different aircraft flying down together," recalls Gene Hood, who worked at Arnold as an associate engineer—specifically, a scientific glass blower ("The mad scientist with all the racks of glass? That's what I made for a living," he explains). "We went to a fly-in at Rome, Georgia, and we came in formation

with [Piper] Twin Comanches, Cubs, PA-12s, and [Cessna] 172s, 182s, all flying in a gaggle. Old Curly Broyles, one of our staunch supporters, was running around the airport hollering, 'Here they come! Here comes that Tullahoma bunch!' And that's the way it started. We decided we ought to organize."

"We picked the banana kind of as a trademark," Schulz says. "I had a guy ask me, 'Other things come in bunches—how about a grape?' And I said, 'There's nothing funny about a grape.' "

Wade McNabb (right), the museum's CEO, is also the curator. Below: Portraits of Walter and Olive Ann Beech flank a Staggerwing showing off its bones. Below, right: Olive Ann (at left) and Louise Thaden beam...

a 55-gallon drum."

Meanwhile, through Dub Yarbrough, the Tullahoma Bunch became well acquainted with Staggerwings and offered to host the club's annual conventions. At the time, Staggerwings were regarded as curiosities more than classics. But the Tullahoma crew, appreciative of all the aircraft it represented, began to take a proprietary interest in the airplane. The fly-in would draw some 40 Staggerwings. By that time, Parish owned a Staggerwing too ("I went to the Antique Aircraft Association fly-in in Ottumwa, Iowa, and I saw

NASM (83-2143)

...with a Beech Musketeer in 1963. Below: As a sign says, when members die, the museum follows a military ritual.

Soon the Tullahoma Bunch were wearing banana lapel pins, name tags, and jackets with banana patches. The group founded an Experimental Aircraft Association chapter, no. 458, and the president was Top Banana. Another member was Rotten Banana. Staggerwing Club president Dub Yarbrough's wife was a Green Banana "because she didn't like to fly."

Hosting their own fly-in was the next step. "Somebody said, 'Well, what are we going to do?' " Hood recalls. "And I said, 'Just do nothing. Let's just let it happen.' And that became the name: The Happening."

"That came out of the hippie, '60s generation," says Schulz, who, with his wife, Mattie, was among the museum's first officers. "That was sort of a saying at the time."

"It really became a very popular, really big fly-in," Parish adds. "Everybody would fly in to Tullahoma for the Happening. Everybody made chili and dumped it in

this biplane and I fell in love with it immediately, and I said, 'I've got to have one of those!' ").

By the early 1970s, the Happenings were on the OUT list, and the Staggerwings were IN.

Christine St. Onge, a nurse from Wexford, Pennsylvania, was a brand-new pilot when she came to her first fly-in, in 1974, eager to see the aircraft whose appearance in photographs had so captivated her. "The airplane had a charisma or aura about it that I just couldn't shake,"

she says. "I met Louise Thaden. She wanted to know how I got into aviation. She said, 'I have a feeling you're going to be just like me: get married, have kids, but still fly a Staggerwing.' And I thought, *Nah, there's no way I'm ever going to find a guy that's going to let me do all this.*"

"All this" refers in part to her 1936 C17B Staggerwing. Her son, Joseph, now 27 and assisting with a preflight inspection, has been accompanying his mother here since he was a baby. (Husband Paul, who is not a pilot, encouraged her to buy the airplane, which she displays at airshows.)

"I don't see the Staggerwing leaving the family any time soon," Joseph says. "I'm aware of its heritage and history. We're pretty much the only touring Staggerwing on the airshow circuit in the Northeast, and it's great to be able to share it with people that have never seen one before, and have people come up and say, 'Oh, I haven't seen one of these since 1940-something!'"

Christine St. Onge, here with son Joseph (right) came to the 1974 fly-in to see a Staggerwing up close. Below: Bud Fuchs calls his Model 17 an "antique-classic-warbird."

THE YEAR OF ST. ONGE'S first visit was also the year the Beechcraft Staggerwing Museum opened, on land donated by the Parish family. As an incentive to create the museum, Louise Thaden had promised to donate her papers and memorabilia, and a small log cabin had been built to house the material. By then an even younger generation of Staggerwing enthusiasts was coming along. From the first Staggerwing fly-in, John Parish's three boys—Charles, Robert, and John Jr.—and Wade McNabb, son of the museum's first curator, Glen McNabb, served as greeters, wiping down each aircraft when it arrived and keeping the grounds spotless. "The pilots started giving us tips," McNabb says, "so we would donate our tips to the museum at the end of the week."

The years passed and the museum expanded—more buildings, more Staggerwings, more exhibits. Early on, the progress was noted back at Beech headquarters in Wichita. Olive Ann Beech, whose attitude toward the museum had mellowed, sent crates of documents, including original blueprints vital to rebuilding and restoring the aircraft. In 1975, Beech made her first visit to Tullahoma for the dedication of the Walter H. Beech Hangar, housing airworthy Staggerwings and Travel Airs, along with the original Staggerwing wind tunnel model and the prototype for the landing gear retraction mechanism. (She retired in 1982, two years after Raytheon bought her company.)

Below: Lost? Just follow the signs. Bottom: Three generations of Parishes surround the family's G17S.

BOB BURNS

Youngsters grew and earned pilot's licenses, and some graduated to the left seat of the family Model 17.

"I learned to fly a Staggerwing by watching my dad: I remember watching everything he did," Wade McNabb says. "And finally I talked him out of the keys to it. I was 22 and it was during a convention. The airplane hadn't flown in two years because my dad was ill, so I took a vacation, came here, annualed the airplane with a local mechanic, and one of dad's friends came here and checked me out in the airplane."

In the mid-1990s, members of the museum's board realized a focus on Staggerwings alone could not sustain the fly-

St. Onge, who shows off her Staggerwing at airshows in the Northeast, had her 1936 C17B done up in "Louise Thaden and Blanche Noyes colors" that replicate the paint scheme of the 1936 Bendix Race winner.

in or the institution that hosted it. Owners were getting older and fewer airplanes were making the annual migration to Tullahoma. Members of a society devoted to the Beech Model 18, and later, of the American Bonanza Society (Bonanza, Baron, Debonair, T-34, and Travel Air), were invited to display their aircraft at the fly-in.

"It was a little stressful," Parish admits. "Some members felt we should stay focused just on the Staggerwing. But we found Twin Beech people were just like us, all part of the same family, and the same thing happened with the Bonanza [and] Baron."

In 2007, the institution changed its name to the Beechcraft Heritage Museum, dedicated to "preserving the heritage nurtured by generations of enthusiasts of all Beechcraft models." "If you don't change, you die," says museum president Michael Greenblatt, one of the institution's new generation of leaders. "What we're doing is promoting the Beechcraft heritage, but also promoting the love of aviation." Today, counting the nine Staggerwings (including serial no. 1, a 1932 17R that was destroyed in a crash in 1935 and returned to airworthiness in the late 1980s), the museum has some two dozen Beech aircraft, ranging from a 1925 Travel Air Model 1000 (serial no. 1) to a Model 2000A Starship.

Wade McNabb, who had become an engineer and worked at Pratt & Whitney, serves as the museum's curator and chief executive officer. Robert Parish—whom many attendees still remember as one of the kids welcoming them to the fly-ins years ago—is on the cover of the museum's brochure, in a photograph that shows him at the controls of *Big Red*, the family's 1946 G17S Staggerwing, N44G.

Early one morning he and I prepare for a flight. "I grew up in the back seat of this airplane," he tells me, "and now my wife and three kids fly all over the country in this."

After making a preflight inspection and then priming the engine, Parish engages the starter. The prop begins turning, and the radial engine catches with a belch of smoke. I'm reminded of something Michael Greenblatt said: "When you get in the cockpit and you fire it up, and you smell the smoke and the oil, and it's rattling and popping and screaming while the mist is hanging out over the runway, and finally things warm up as the sun breaks across the horizon, and you light off into the sky...it is just nostalgic beyond belief."

On the last morning of the 2008 fly-in, the Parish clan gathers for a photo, squeezed together around the tail of N44G. The youngsters are impatient at the imposed moment of inactivity.

Someone shouts: "Who wants to fly a Staggerwing when they grow up?'

Eight-year-old John Parish III's hand shoots up to the sky.

Some mysteries of planetary magnetism have yet to yield to the rockets of Poker Flat.

The Shining

Story and photographs by Tim Wright

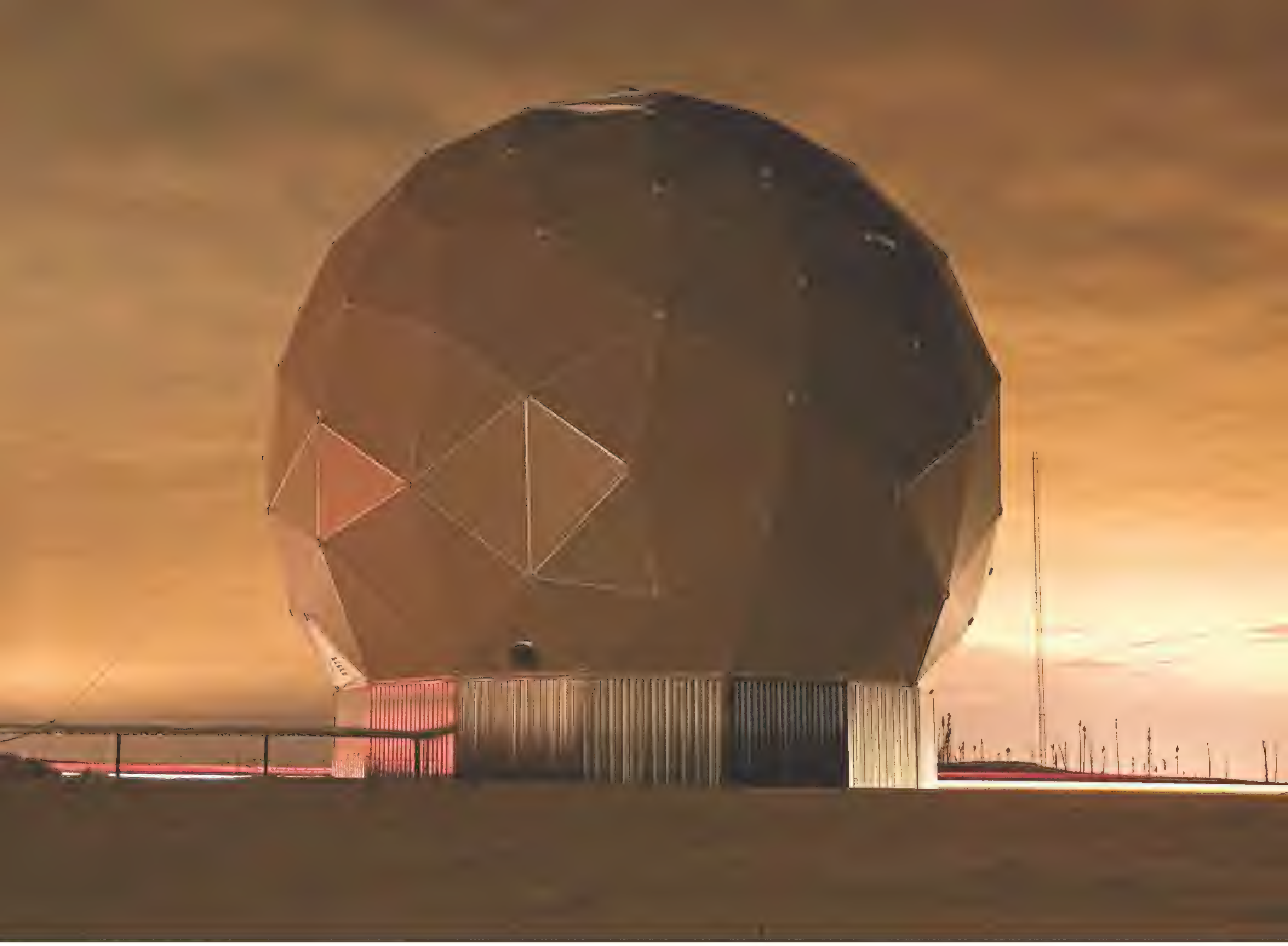
What first appeared almost an hour ago as a strange green cloud in the northeast has now spread across most of the sky near Alaska's Poker Flat Research Range. Sheets of green light shimmer in front of the stars, waxing and waning, as electrons from the solar wind rain down through Earth's atmosphere, colliding with atoms and creating the aurora. Here, watching the light show under a zillion stars, I get a strong, almost physical awareness of being on a planet—a planet orbiting a star and connected to it, despite the 93 million miles of space separating them.

A loud roar breaks my reverie, and a bright point of light rapidly climbs almost straight up into the sky. A two-stage Terrier-Orion rocket is streaking into the ionosphere. Seconds later, its first stage plunges toward Earth accompanied by a high-pitched whistling sound. With a shower of sparks, the first-stage rocket motor slams into the blackness, igniting a small fire among the trees. As the last of the rocket fuel burns, the fire illuminates an otherwise invisible, snow-covered ridge. Only the NASA tracking radar has any idea where the rocket's second stage has gone. Before the long February night is over, the temperature will drop to –21 degrees Fahrenheit and three more Terrier Mk 12 Improved Orion rockets will scream off into skies draped with the green of the Northern Lights.

The fiery tail of a Terrier-Orion rocket draws a line in the sky near Fairbanks, Alaska, where the Poker Flat Research Range has supported studies of the aurora for 40 years. Scientists and grad students come and go, but science operations manager Brian Lawson (right) and six other technicians staff the range year-round.

Rockets from Poker Flat have been penetrating the aurora since March 1969, shortly after an international incident forced all U.S. military research programs to leave Greenland, a prime location for aurora research. In January 1968, a B-52 bomber with four thermonuclear weapons crashed near Thule Air Base; it was one of the worst nuclear incidents in the cold war. (All four bombs were destroyed and plutonium was scattered across the sea ice.) Responding to public outrage, the Danish government ejected U.S. military researchers.

The U.S. military was interested in the aurora because it had the potential to distort radar returns and because high-altitude nuclear tests in the 1950s and early '60s had created auroras and electrical disturbances similar to those accompanying intense auroras. The Pentagon worried that its early-warning radars could be blinded or deceived. Neil Davis, a scientist at the University of Alaska Geophysical Institute who participated in military experiments in order to do basic research on the magnetosphere, explains the danger posed by auroras: If a single rocket was passing through the aurora, "all of a sudden, that single rocket looks like lots of rockets." Intense auroras reflect radar like a piece of crumpled aluminum foil reflects the light from a flashlight. That



Beneath clouds glowing from the lights of Fairbanks, a dome-covered antenna tracks commercial satellites. Neil Davis (right) was a prime mover in establishing Poker Flat; its science operations center is named for him.

"false positive" could have unleashed a massive retaliation.

By the time of the military projects, Davis had conducted a study on the feasibility of building a new soundings-rocket launch site 30 miles northeast of Fairbanks. That was about the time his team was disinvited to come to Greenland. The Greenland fiasco, therefore, turned out to have a silver lining for the Geophysical Institute: It was able to develop the 5,000-acre launch site with Pentagon funding. "I didn't expect it to last over 10 years when we started," says Davis today.

The four Terrier-Orion rockets launched last February were part of an experiment by Gerald Lehmacher, of Clemson University in South Carolina, to model high-altitude turbulence. The rockets released chemicals that interact with atomic oxygen to form luminescent clouds, which can then be photographed over time to measure wind speeds and map wind directions. Because bright and extensive auroras heat large volumes of the upper atmosphere, they may in-

fluence global weather patterns, and the Clemson study is an attempt to understand the convection caused by the interplay of electric current and winds. It is also an example of how many different systems the aurora affects. Don Hampton, the optical science manager at Poker Flat, lists a few, besides Earth's weather: power grids, satellite orbital mechanics, pipelines (which corrode from induced electrical current), nuclear power, and solar weather. Of course, researchers are also interested in such basic science as Earth's electromagnetism and the behavior of plasma, or ionized gas. "Ninety-nine percent of the universe is made of plasma," Hampton says. "It's just important to study plasma in all its forms, and when you get to aurora altitudes, it's pretty much nothing but plasma. We've made great progress in understanding auroras, but there's still plenty to be learned."

One of the reasons the aurora has been difficult to study is that the interactions between solar particles and the atoms and molecules in the atmosphere start at the atmosphere's outside fringes and continue down to roughly 100,000 feet—a region of the sky too high for aircraft or most balloons but too low for satellites. (People who have seen the Northern Lights find that hard to believe, because the aurora sometimes appears low in the sky, giving the impression of being close by.) The only measurements of the aurora in the lower region have come from sounding rockets, usually surplus ground- or air-launched anti-aircraft missiles. Carrying instruments to as high as 900 miles, well above the orbits of the space shuttle and International Space Station, they have been part of an effort to understand Earth's magnetic environment—and the sun's impact on it—since the early 1950s.

Sitting at his kitchen table in Fairbanks, Neil Davis, now an emeritus professor, leans back and looks out a picture window, past bird feeders and falling snow. During his career, he traveled the world trying to unlock the aurora's secrets, but the best place for rocket-borne investigations, he says, is right here at Poker Flat. "You get a lot more opportunities" to launch, he says, because the range is located just south of the aurora zone, a region surrounding the poles that sees an aurora almost every day. "And you're shooting north," he adds, across the aurora, which tends to run east and west, "so you can penetrate auroras. And you have this great land mass going all the way to the Arctic Ocean to do recoveries on payloads." Logistics are easier too, says Davis. "You've got a railroad coming in here, a major city to support

The greeting at the launch pads, which make up a small parcel of the 5,132-acre range. Below: From the telemetry center, a Black Brant XII rocket, the largest launched at the site, appears small against the wooded Alaskan hills.

things, and military bases" to assist payload recoveries.

What scientists have learned so far is that the sun spews a constant stream of charged particles and energy: the solar wind. Most of the particles that stream past Earth are deflected by the planet's magnetic field, and flow around it like water flowing around a rock. Some penetrate the field and are trapped in the Van Allen belts, rings of charged particles around Earth; still others spiral down the field lines at Earth's North and South Poles. These particles, typically electrons, hurtle downward along nearly vertical lines with enormous kinetic energy. Scientists have clocked the electrons moving at 248 to 466 miles per second when they strike the magnetosphere, and at up to 36,847 miles per second as they whirl down field lines, but are unable to explain what causes the acceleration.

A typical Alaskan sky, photographed from Eielson Air Force Base, 25 miles southeast of Fairbanks, displays auroral structures and motions that scientists still find mystifying. Right: In a custom styrofoam box that protects it from the cold, a Black Brant rocket waits to blast off.

ABOVE: USAF/ SENIOR AIRMAN JOSHUA STRANG

As the electrons descend, they repeatedly strike atoms of hydrogen, oxygen, or nitrogen, losing energy with each collision. Eventually the atmospheric atoms, which have absorbed the energy, release it as photons. Billions of escaping photons create the familiar sheet-like structures of the aurora.

While auroras occur 24 hours a day and circle both poles, their light is so dim they can be seen only at night or from spacecraft. The color of the light depends on what kind of atom was hit and how hard. The vast majority of auroras are green,

but it is not uncommon to see violet or blue.

When a solar flare erupts, the hail of electrons strikes Earth's magnetic field with enormous energy in what scientists call a magnetic storm, and the auroras redden and extend beyond the polar regions toward the equator. It must have been during such an eruption that the astronomer Galileo got his first glimpse of an aurora, observing it from Italy in 1619. He theorized that the night displays were reflections of sunlight. It was Galileo who coined the word "aurora" for the lights, Latin for "dawn."

During launches, a range safety officer blocks a nearby highway, where rocket parts have landed. Don Hampton, optical science manager at Poker Flat, holds an "all sky camera," used to photograph the aurora from horizon to horizon.

On March 13, 1989, a magnetic storm struck, so severe it shut down Canada's Hydro-Québec power grid in seconds. Six million people in North America lost electricity, some of them for days, and auroras were spotted as far south as Texas. Through induced current, long metal structures, in this case Hydro-Québec's powerlines, develop intense electrical loads. Because induced currents corrode metal, the Alaska pipeline is affected. But understanding how to protect pipelines and power grids are only two of the practical applications of knowledge about Earth's magnetic environment. Scientists developing fusion reactors to supply power are also interested in geomagnetism.

"One of the justifications that has often been used for doing studies of the aurora is the potential application of what's learned there on thermonuclear energy," says Neil Davis. "The problem in developing thermonuclear energy is that you gotta contain material, very hot material" in a plasma state. Because no man-made material can tolerate the temperatures created in fusion reactions, scientists are experimenting with magnetic fields to contain and control the process.

"The aurora is a beautiful laboratory without walls," continues Davis. "So if you can learn about those plasmas, there's potential to apply that knowledge to the development of thermonuclear energy."

Several nights after the Clemson launches, Brent Sadler, a graduate student from the University of New Hampshire, is waiting in a launch control blockhouse for the countdown clock to advance. For most of the night the clock has been holding at the routine mark of T-minus 10 minutes because steadily falling snow and cloud cover obscure the aurora and interfere with observations down range. If everything works as planned, the 58-foot-long, four-stage Black Brant XII, carrying a camera and five other sensors, will pass through the aurora and photograph it from above.

Kristina Lynch, professor of physics and astronomy from New Hampshire's Dartmouth College, is the principal investigator for tonight's project. "After the [third-stage] motor burns, we're out of the atmosphere," she says. "We fire the fourth motor and get as high up as we can." That turns out to be about 370 miles, after an eight-minute flight. The five sensors, each with a GPS transmitter, will send measurements and positions to ground receivers. "There are a lot of theories about how different structures in the aurora are formed and controlled and the physics behind making a structure two meters across compared to one that is five meters across," says Lynch. "But there's not a lot of actual, measured data. So our hope is to have a very finely constrained data set that theorists and modelers can use to judge their theories and models."

A crudely formed styrofoam box protects the rocket from the cold. Snaking around the massive steel gantry, a large yellow hose, connected to a roaring aircraft heater in a blockhouse 30 yards away, carries hot air into the box to keep the rocket around 70 degrees. "The rockets that we fly here all have solid fuel in them," says Ray Martinez, who has worked at Pok-

er Flat for almost 20 years. When it's time to launch, it's Ray Martinez who pushes the big red button. "If we were to let the propellant within the rocket motors get cold, it would shrink—it would pull away from the case of the rocket motor," he explains. If a void forms, the fuel can burn through and destroy the rocket. The 70-degree goal requires attention 24 hours a day, according to New Zealander Brian Lawson, one of seven permanent employees at Poker Flat and the man responsible for keeping its computer and voice communications hardware running. "It's not uncommon to launch at 40 below," he says.

It seems counter-intuitive, but Sadler is worried that the camera riding atop the rocket is getting too warm. The colder the imager, the more sensitive it will be to the aurora's light. "It's sort of a dilemma," says Lawson. "The rocket motors like to be warm, and the instruments like to be cold."

Sadler is escorted from the launch control blockhouse out to the snow-covered launch pad where the rocket waits under the steady glare of floodlights. Moving as quickly as the subzero temperature and his bulky clothes allow, he brushes snow off a cooler outside a nearby blockhouse and reaches inside with heavily gloved hands. A man in a hurry, he dismisses my half-hearted joke about making a beer run by explaining he's after a block of dry ice.

Ice in hand, Sadler hustles to the launcher. Opening a small hatch in its base, he climbs into a cramped space and spreads the ice over black hoses that pass through a cooler and up to chill an aluminum block supporting the digital camera.

For the dozens of folks who work on a soundings rocket project, a 30-minute break in the weather can be all it takes to end weeks of tension and boredom. The principal investigators, sitting with their computers on top of a nearby mountain, are under intense pressure to decide whether conditions at Poker Flat are good enough to launch. High-altitude winds, passing clouds, weak auroras, or bad weather at remote observation sites downrange can scuttle a launch. With years of work and as much as several million dollars riding on their decisions, the nightmare for the principal investigators comes when conditions are marginal. That's when science becomes a high-stakes poker game.

Tonight, the weather wins the hand. At 1 a.m., the launch is scrubbed. Almost five weeks later, the Black Brant carried the camera and five sensors into a vibrant aurora. Lynch's team is now analyzing the data and expects to make the next incremental contribution to the body of knowledge collected by the rockets launched from Poker Flat.

Launch officer Ray Martinez (top) scans a pre-launch checklist. He'll see the launch on a TV screen, courtesy of cameras on the pad (left). An iced-over wind guide (above) helps point tracking radars. Opposite: High above a telemetry antenna, artificial clouds mark turbulence, as the aurora glows near the horizon.

The **Bear** Is Back

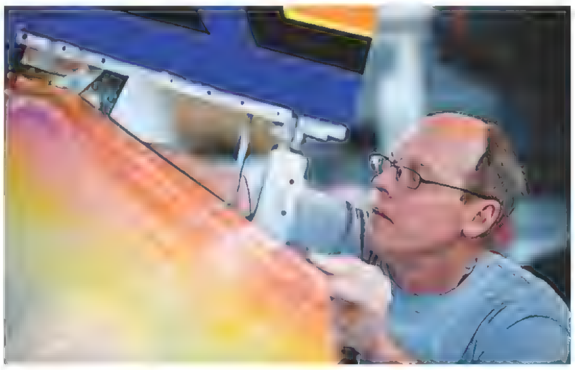
Can an air racing legend win again at Reno?

by Preston Lerner | Photographs by Tyson Rininger

AFTER A WINTER spent licking the wounds from battles lost last fall, the Bear stirs, indifferent to the bracing wind and brilliant sunshine. It emerges slowly from its cave, pauses to orient itself, then gravitates toward its natural hunting ground: not a forest or a river full of salmon but the ramp of the Reno-Stead Airport in Nevada. Here, for four decades and counting, the Bear has stalked its prey: Sea Furys, Lightnings, Super Corsairs, and, tastiest of all, the fleet, slender thoroughbreds known as P-51 Mustangs.

Like a runner waiting for the starting gun, the famous Grumman F8F-2 (without wingtips) looks ready.

"God, it's just such a big, handsome, good-looking critter," says crew chief Dave Cornell as he watches the freshly painted airplane roll past the lesser creatures parked nearby. "It's got a fine wing and a ferocious engine, a sturdy and rugged landing gear—everything you need for air racing. The Mustang has a wonderful laminar-flow wing, and it would be fun to race. But just in terms of going around Reno, it's really tough to beat the *Rare Bear*."

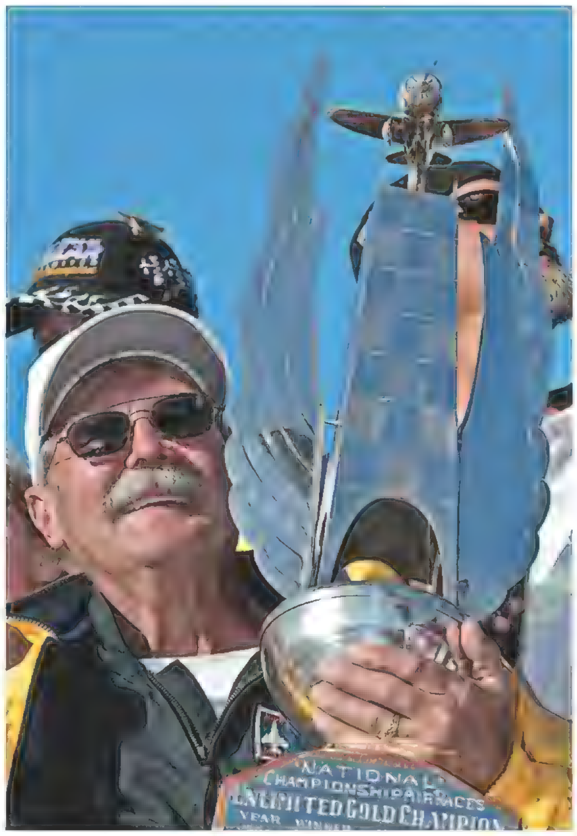


Seldom has a warbird been more aptly named. Packing up to 4,500 horsepower in a muscular 8,700-pound package, *Rare Bear* is a radically modified, one-of-a-kind version of a Grumman F8F-2 Bearcat. It has won more Unlimited races than any airplane (the Unlimited category is open to any piston-driven aircraft with an empty weight greater than 4,500 pounds, typically stock or modified World War II fighters). *Rare Bear* also holds the three-kilometer speed record—528.33 mph—making it the fastest piston-powered, propeller-driven aircraft in the world. But what sets the *Bear* apart from its rivals is the cult that surrounds it.

In a milieu dominated by million-dollar airplanes and zillionaire sportsmen, *Rare Bear* has been the people's choice, the low-buck underdog that triumphed against all odds. The team has made ends meet by selling not only T-shirts but also used engine oil (marketed in vials as "Bear Blood"), and the vast majority of people who have worked on the airplane have been volunteers. "There were times when I stayed on after the races and washed down the airplane myself because everybody else was so worn out," says Chris Rakestraw, a retired TWA flight attendant who now works as the team's administrative coordinator. "I understand that it's just a piece of metal. But it's taken on a life force of its own."

For most of its life, the *Bear* exuded the can-do personality of longtime owner Lyle Shelton. A naval aviator turned TWA pilot, Shelton plucked the derelict Bearcat out of an Indiana weed patch in 1968. Then he begged, borrowed, and promoted like crazy to customize the airplane with an oversized Wright R-3350 radial engine, transforming the wreckage into a winning racer. Even the people who know him best are mystified at how he accomplished so much with so little. But Shelton didn't just own the *Bear*; he flew the bejeezus out of it, collecting six Golds at Reno as well as winning races at Mojave; Miami; Hamilton, California; and Cape May, New Jersey. "It was a big part of my life," says Shelton. "The *Rare Bear*

Mechanic Keith Geary (above) and crew chief Dave Cornell (below) have been working 12-hour days sometimes seven days a week to ready *Rare Bear* for its return to Reno.



ARNOLD GREENWELL (2)

John Penney (above, right) flew *Rare Bear* to a championship in 2007 and hopes to avenge last year's loss at Reno (above).

Right: In 2007, mechanics Chris Langham and Matt Thompson, telemetry specialist Clark Thompson, aircraft owner Rod Lewis, and mechanic Brian Grizalski (left to right) celebrated engine installation.

WAYNE SAGAR/AAFO.COM

project was probably the most riveting that I ever got into. We didn't have big investors or big sponsors. We just did it because we wanted to do it."

Shelton belongs on the short list of greatest air racing pilots ever. But what made him such a crowd favorite was *how* he won his races. "Fly fast" was his motto. When he retired, he turned over the flying duties to another military-aviator-turned-airline-pilot, John Penney. Although Penney didn't have Shelton's swagger, he scored back-to-back victories in 2004 and 2005. But money was tight. Shelton had no personal fortune to draw on, and sponsors were impossible to find. An engine meltdown in 2006 seemed to be the end. But the *Bear* has always depended on the kindness of strangers, and so it proved then, in the form of San Antonio oil man Rod Lewis.

"I think I've been to every Reno air race since '95," says Lewis, a major-league warbird collector who owns three stock Bearcats and *Glacier Girl*, the world's most famous P-38 (see "Glacier Girl," Feb./Mar. 2004). "I've always liked the sound of *Rare Bear*, and I've always liked the look of *Rare Bear*. Sometimes we'd see it race, but not all of the time, because of, ah, economic issues. It was a really lean, low-budget operation. Some years I'd see Lyle sitting there with a coffee can, looking for donations."

In 2006, after several months of negotiations, Lewis bought the *Bear*, paying just under \$2 million. Since then, he's spent almost \$2 million more refurbishing and upgrading it. In 2007, Penney rewarded Lewis' largesse with a Cinderella win at Reno. But last year was a nightmare. The spray-bar oil cooling system ran dry after a qualifying heat during the week, and the engine overtemped, setting it up for failure. Sure enough, on Sunday, Penney started the Gold race down on power, and the engine blew before he reached the finish line.

Modified 3350s don't grow on trees, so there's plenty to do before the *Bear* can race in 2009. Here in Reno, the work is coordinated by team manager Alby Redick. Twenty years ago, he helped start the movement to import Soviet bloc jet fighters to the States. (He still runs a company called Aviation Classics Limited, known informally as MiG Alley.) But his father was a mechanic at what's now the Planes of Fame Air Museum in Chino, California, so he grew up surrounded by World War II aircraft.

"When my father would ask me what I wanted to do, I'd whisper, 'I want to sit

No part of the rebuilt warbird escapes the team's attention (left). Sporting a new orange-and-purple paint scheme befitting a hot rod (above), the *Bear* (opposite) has been hugging pylons at Reno since 1969.

in the Bearcat,' " Redick recalls. "I know it's not a consensus view, but I think it's prettier than the P-51. And there's something about the mixture of 60-weight oil and avgas coming out of a round motor. I could stand in back of one and"—he inhales deeply—"all day. And the sound! I don't care who are you. You stop and look around when the *Rare Bear* is flying."

In Reno, Redick has two mechanics, Keith Geary and Robbie Grosvenor, working full time on a boil-off oil cooling system and other *Bear*-related tasks. But the rest of the project is being farmed out all over the country. Crew chief Cornell is building a new engine in Oregon. Clark Thompson is designing a telemetry unit in New Mexico. Executive Propeller is overhauling the prop in California. If all goes well, the *Bear* will be buttoned up early enough to enable Penney to get in a few hours of flight testing before the mid-September races.

But prepping a warbird for Reno is always a crapshoot. As the crew members work through their scrupulously detailed checklists, countless gremlins wait to foil them. And when you're talking about a warbird, no problem is small. Parts aren't available at the local Sears. In many cases, just unscrewing bolts and prying apart components require special tools. As the race deadline approaches, the job almost inevitably devolves into a thrash. Work hours accumulate. Frustration grows. Tempers flare. Are we having fun yet?

But that moment, if it arrives, is several months away. On this sunny day in late April, everybody is all smiles as they watch the resplendent airplane being towed from the cramped hangar that had been its home to a spacious new *Bear* cave elsewhere at the airport. Watching the airplane move past a pair of MiGs, Cornell has a proprietary gleam in his eye. He started working on the *Bear* as a volunteer in 1978, then in the late '80s served as the crew chief before getting crossways with Shelton and leaving to work on Mustangs and Sea Furys. Rod Lewis re-hired him in 2007, and he's been on *Bear* patrol ever since.

"Since I've been on this project, I've pretty much worked 12 hours a day, seven days a week," he says. "I've taken a few days off. But not very many. Maybe 10 in three years. So I've spent, and this entire team has spent, just a huge amount of time to get this baby back to where it used to be. And it's back." He laughs like he really means it. "The *Bear* is back."

IT'S HARD TO IMAGINE NOW, when air racing is treated like an exotic curiosity, but there was a time, in the 1930s, when the sport attracted so much attention it made aviators such as Jimmy Doolittle and Roscoe Turner national celebrities. But after World War II, air racing faltered. In 1964, Bill Stead resurrected the sport, staging a race over a pylon-delineated course at a remote airfield near Reno. The spectators for the inaugural event included a 31-year-old U.S. Navy lieutenant who was there in part because he'd been so hungover he'd missed his flight to Hawaii. His name was Lyle Shelton, and in Reno, he discovered a passion that was to animate the rest of his life.

That first year Shelton worked as a volunteer on a couple of Unlimited aircraft. During the 1965 off-season, acting on the advice of Alby Redick's father, he persuaded a warbird owner to let him race a stock P-51D. To drum up sponsorship, he flew the Mustang to Tonopah, Nevada,

When he's not managing the team, Alby Redick imports Soviet bloc aircraft to the U.S. through his Reno-based company Aviation Classics.

made a screaming low-level pass over town—inverted—then landed and passed the hat at the local businesses. According to Shelton's good friend Dell Rourk, who wrote *Racing for the Gold: The Story of Lyle Shelton and the Rare Bear*, his biggest benefactor was the madam of the town cathouse. In her honor, he named the airplane *Tonopah Miss*. In his first race at Reno, Shelton finished at the back of the pack.

In those days, warbirds were selling for peanuts. Even so, Shelton couldn't afford a flyable one. So in 1968, during a TWA layover at Chicago O'Hare Airport, he drove to Valparaiso, Indiana, to check out a wrecked Bearcat. The pilot had botched a landing and the airplane had cartwheeled. For six years, it had languished in two sections. The engine, wingtips, right landing gear, instruments, cockpit controls, and several other critical systems were missing. The owner was asking $2,500. Sold!

Toward the end of World War II, Grumman designed the Bearcat as a replacement for the U.S. Navy's F6F Hellcat fighter, and the Bearcat was revered for its superb maneuverability and climb rate. The winner of the first air race at Reno was a stock Bearcat flown by Mira Slovak, and the Unlimited class, starting in 1965, was dominated by Bearcats flown by Darryl Greenamyer. (One of his aircraft, fittingly named *Conquest 1*, is now on display at the National Air and Space Museum.) Relying on the racing verity that there's no replacement for displacement, Shelton planned to beat Greenamyer by replacing his aircraft's original engine, a Pratt & Whitney R-2800, with a more powerful modified Wright R-3350.

On a rainy December afternoon in 1968, Shelton and Cliff Putman, crew chief at the time, trucked the Bearcat to an airport in Compton, south of Los Angeles. Bill Hickle, a Northrop structures engineer and wannabe air racer who rented a hangar at the airport, saw them roll up. When he walked over to investigate, Shelton asked him if he knew anybody with a welding rig.

"Well," said Hickle, "I've got a welder over in my hangar."

Shelton: "We need some repairs to this thing. Do you know anybody who could do it?"

Hickle: "Basically, that's what I do for a living."

He went to work on the airplane, first doing structural analysis, later as crew chief. Now 69 and white-haired, running an aircraft service and repair business, Hickle still volunteers to work on the *Bear* even when it means making paying customers wait. "I haven't seen every flight in between," he says, "but I'm the only one that I know of who's seen the first flight and the last flight. I've been 40 years on the *Rare Bear*, and I'll not get involved with another airplane. This is the one that's got my attention. It's like my only child."

The Bearcat was painstakingly reconstructed with a donated R-3350 engine of unknown provenance shoehorned into the cowling. Nine months after he had trucked the wreck to Compton, Shelton flew the airplane to Reno for the 1969 races. Hickle remembers people looking at the big engine, shaking their heads, and muttering, "You stupid suckers." Nobody

WAYNE SAGAR/AAFO.COM

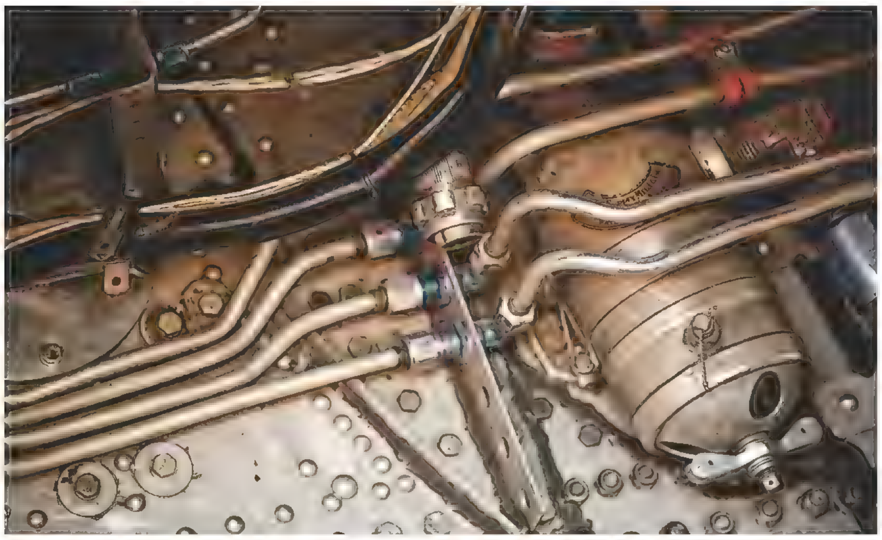
in air racing had tried such a radical conversion before, and the Wright radial was still dogged by a reputation for setting B-29s on fire during World War II. Sure enough, the first engine blew up. In 1970, another 3350 of uncertain vintage also went kerplooey.

For the 1971 race, Shelton got an engine customized by Mel Gregoire, who had been servicing Wright radials since 1950. Gregoire worked for Aircraft Cylinder & Turbine in Sun Valley, California, and company owner George Byard donated the engine to Shelton. "I don't know if there's anybody alive who's worked on those engines longer than I have," says Gregoire, who is, at 91, still Cornell's guy for engine advice. Gregoire knew that during the 1950s and '60s, ultra-rugged versions of the 3350 had been developed for airline and military use. The engines were too big and heavy for air racing, but their pieces were stout enough to withstand extreme stress, so Gregoire mixed and matched components to create a one-of-a-kind monster. From a Lockheed L-1649 Starliner, he took a nose case designed for a slow-turning prop and mated it to the so-called power section—crankcase, crank, pistons, and cylinders—lifted from a Douglas DC-7 (which also provided the *Bear*'s engine cowling).

Shelton and the hot-rodded *Bear* won their first race at Cape May in 1971, then, beginning in 1973, finished first three times running at Reno (though he was disqualified in 1974 for not pulling up during a caution). But boom was followed by bust. After a blown oil line, then a gear-up landing at Mojave in 1976, there was not enough money to repair the airplane, so the *Bear* sat forlornly at Van Nuys Airport, without an engine or obvious prospects.

One of the witnesses of that spectacular gear-up landing was Dave Cornell, attending his first air race. A self-taught engineer who created special effects for the movie industry, Cornell saw the airplane again a few years later while he was taxiing at Van Nuys Airport during a flying lesson. He volunteered to help get the *Bear* back in the air, and he apprenticed with several of the aging wizards of air racing. But even pumped with plenty of nitrous oxide and a witch's brew of nitromethane, *Rare Bear* couldn't keep up with newer, more sophisticated warbirds. "It dawned on me that if we were going to get in the hunt, we needed a much more powerful supercharger," Cornell says.

He snagged a blower from a Lockheed EC-121. The supercharger had been designed for direct-head fuel injection, a technology that wouldn't fit inside the *Bear*, so Cornell re-engineered the supercharger to work with the existing pressure carburetion system. Normal rated power of a stock 3350 was 2,800 horsepower at 2,600 rpm and 45 inches of manifold pressure. With Cornell's mods, the engine made 4,000 ponies at 3,200 rpm and 80 inches of manifold pressure—4,500 horsepower with a shot of nitrous. With that engine and a slicked-up airframe, Shelton kicked holy butt, demolishing the three-kilometer speed record and dominating at Reno from 1988 through 1991.



Bearcats stash their fuel filters in the gear wells.

M. DANIELS/ILIPS GROUP

Radial engine expert Mel Gregoire has been key to the *Bear*'s victories. The racer (opposite) has won 10 Unlimited Reno championships.

In fact, it was the 1991 Gold race that best showcased the formidable partnership of man and machine. As soon as he heard the traditional call—"Gentlemen, you have a race!"—Shelton hammered down the chute and led the field around the first pylon. Riding his tail were Bill "Tiger" Destefani in the P-51 *Strega* and Skip Holm in *Tsunami*, the great coulda-shoulda-woulda scratch-built racer that never caught a break. Destefani and Holm dogged Shelton for 73 miles, but the *Bear* ran like a scalded 'cat, maintaining a winning gap the entire race. "That was the best race I've ever seen," says Pete Law, a longtime Lockheed Skunk Works thermodynamicist who has provided engineering support for virtually every Unlimited winner at Reno since 1966. "It was the race of all races."

Lyle Shelton never won another Gold.

CHRIS LANGHAM and Keith Geary are perched on ladders as they remove the *Bear*'s propeller. Unlike most other jobs on the Bearcat, this is relatively simple, requiring no special tools or expertise. But

Read a post-race interview with Team Bear and find out Reno '09 results.

ARNOLD GREENWELL

the propeller itself is a rare Douglas A-1 Skyraider unit featuring the latest hub with the earliest blades—so slender they're referred to as toothpicks. "We treat it like an egg," says Langham.

Langham, 42, volunteers when he's not working as a mechanic for a shipping company. He gravitated to the airplane five years ago because it was so different from everything else he had worked on. "The longerons are spot-welded," he says. "We don't do that anymore. The elevator and rudder are made out of fabric. We have to search for months to find some parts. Worst-case scenario, we fab them ourselves. We make our own hoses. We do our own machining and welding. There are times when we work 20-hour days for seven or eight days. But like John Penney says: 'She's a seductive bitch.' No matter what she does to you, you keep coming back."

Hickle estimates that over the years, about 130 people have worked on *Rare Bear*. All but a handful have been volunteers, and about 90 percent of them have been airplane mechanics. At times, when sponsorship was paying the bills, as many as 30 people supported the *Bear* at Reno. This year, the crew will probably be a third that. And already, preparations are running behind schedule. Not because there isn't enough manpower but because Cornell hasn't been able to locate a small but essential component called a master rod bearing.

The good news is that Penney won't need much time to get up to speed. He's already flown the *Bear* to four Golds, and he's intimately familiar with the airplane's idiosyncrasies: the brain-scrambling noise, the *Bear*'s reduced stability at racing speeds, the effort required to manipulate the stick while arcing around the Reno pylons. "It's hard, physical work," he says. "The *Bear* is a fairly docile, well-mannered, nice-handling airplane in the benign flight regime. But at racing speed, it gets kind of hostile. Every time I climb into it, I treat it as a first flight in terms of how focused I am and how much attention I pay to every little detail."

Rare Bear's principal competition at Reno promises to be last year's winner, *Strega*; this year the P-51 will be raced for the first time by 22-year-old Steve Hinton Jr. Next in the pecking order is the Sanders brothers' *Dreadnought*, a Sea Fury that has won two Golds at Reno. For gamblers looking for a dark horse, there's *Czech Mate*, a Yak-11. Six-time winner *Dago Red* won't be racing this year. Ditto for 2006 champ *September Fury*. So the airplane to beat looks to be Race 77, as the *Bear* is known in Reno parlance.

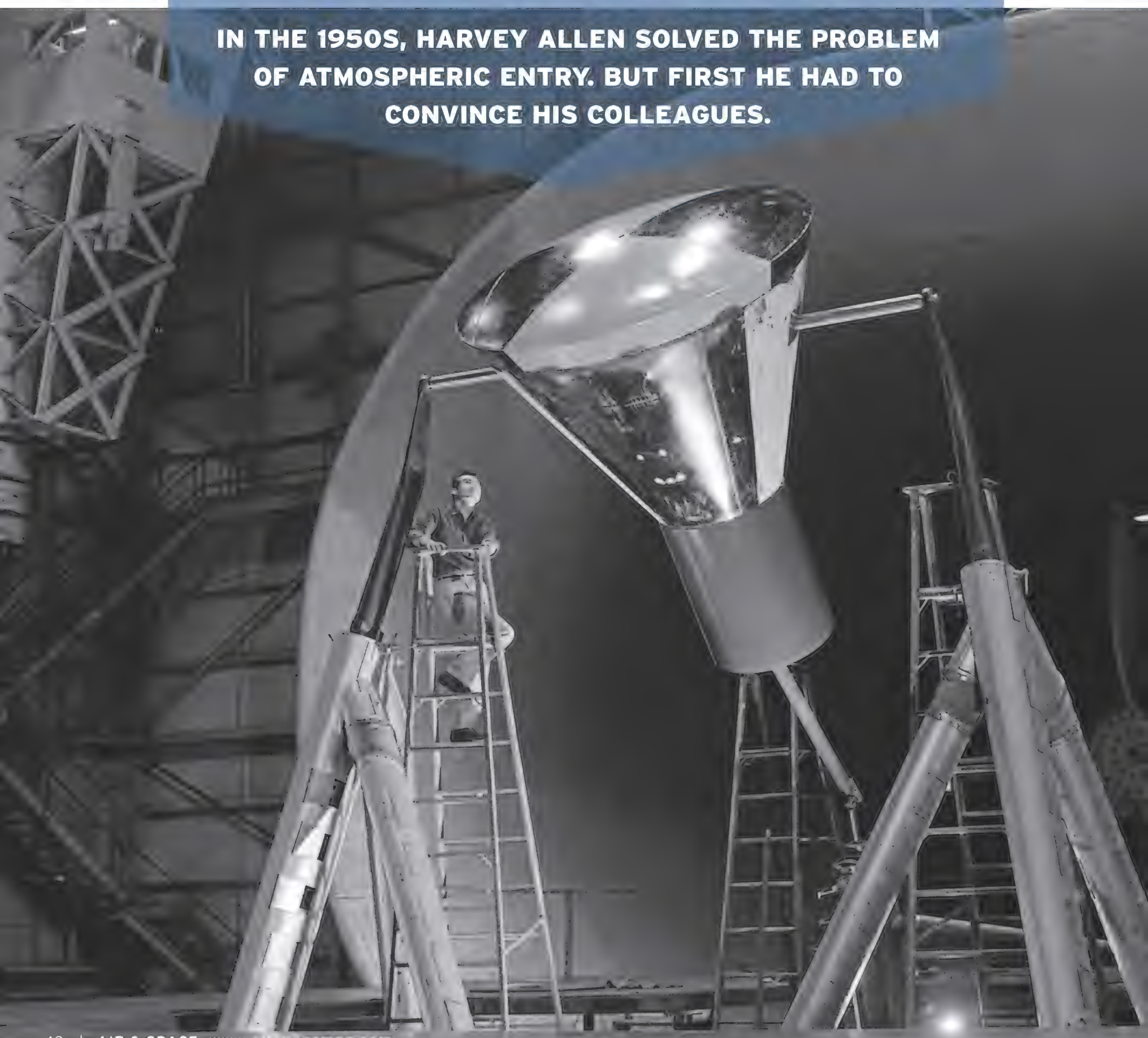
"It'll be Number One, no question," says Pete Law. "With Dave Cornell back on board, it should be head and shoulders above anything that's ever raced at Reno."

The team's goal for 2009 is Gold number 11. "We want to win soundly," says Redick. Next, the three-kilometer record beckons; Cornell thinks 550 mph is a plausible number. And after that? "Everybody involved in this airplane, from the race team to the crew chief to the pilot to the owner, is doing it for the love of it," says Rod Lewis. "So my goal is to continue to do it as long as it's fun."

Sounds like the *Bear* could be in business for another 40 years.

HOW THE SPACESHIP GOT ITS SHAPE

IN THE 1950S, HARVEY ALLEN SOLVED THE PROBLEM OF ATMOSPHERIC ENTRY. BUT FIRST HE HAD TO CONVINCE HIS COLLEAGUES.

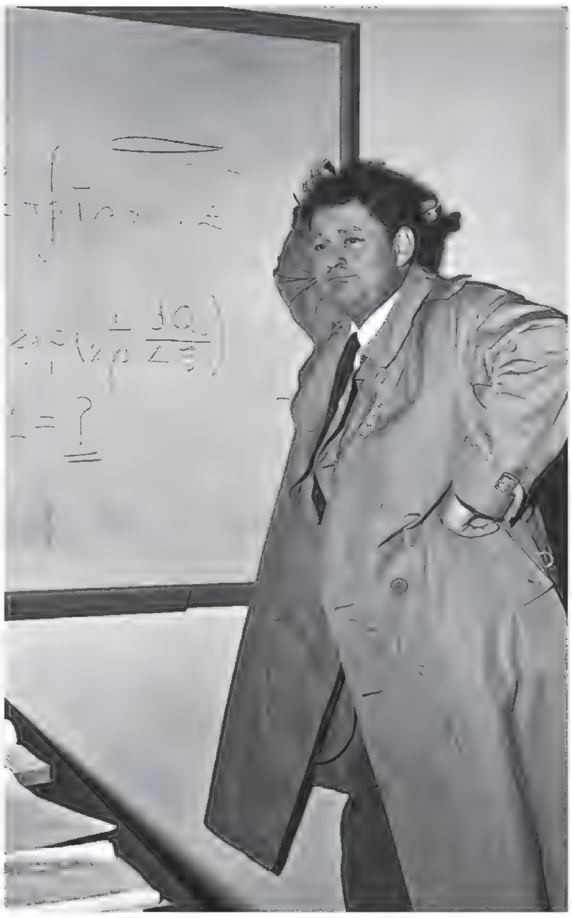


by Andrew Chaikin

THE COVER OF THE March 22, 1952 issue of *Collier's* magazine made an audacious promise. "Man Will Conquer Space Soon," blared the headline, above a painting of a multi-stage rocket with engines blazing, bound for orbit. Designed by German rocket pioneer Wernher von Braun, whose name was still unknown to most Americans, the *Collier's* spaceship was a sleek, needle-nosed beauty; its winged third stage would be piloted to a runway landing. But it was all wrong.

When the Soviet Union and the United States flew the first real spaceships just nine years later—far sooner than most experts had predicted in 1952—they were anything but sleek. One was shaped like a bowling ball; the other resembled a Styrofoam coffee cup. They came back to Earth not gliding on wings but dangling from parachutes. What happened during those nine years to change the shape of spaceflight? It had less to do with dreams of conquering Mars than with the infant science of hypersonics, a classified missile program, and a couple of visionary engineers.

The Mercury space capsule (opposite, during a 1959 wind tunnel test) wasn't on Harvey Allen's mind when he proved the advantages of an entry vehicle with a blunt body. But what was good for bombs turned out to be good for astronauts too.



LEFT: NASA LANGLEY RESEARCH CENTER; RIGHT: NASA AMES/LEE JONES

In the spring of 1952, even as millions of *Collier's* readers marveled at the magazine's visions of the future, engineers were grappling in secret with the almost insurmountable difficulties of designing the first intercontinental ballistic missiles (ICBMs). Creating a rocket with enough power and accuracy to lob a multi-ton nuclear warhead at targets in the Soviet Union, some 6,000 miles away, was challenging enough. But another problem was just as daunting: how to make sure the warhead survived its high-speed reentry from the edge of space. Slamming into the upper atmosphere at 20 times the speed of sound, the warhead would encounter tremendous friction, creating temperatures of 12,000 degrees Fahrenheit.

A protective nose cone would have to be created; the question was, what kind? To minimize friction, conventional wisdom called for using the same kinds of low-drag shapes—thin, knife-edge wings and sleek, needle-nose bodies—being developed for experimental supersonic aircraft like the Douglas Skyrocket. But when models of needle-nosed shapes were tested in wind tunnels, the results were discouraging: At Mach numbers approaching those expected for a real ICBM reentry, the tips of the nose cones began to melt. Something was wrong with the conventional wisdom, and finding a solution would take an unconventional thinker.

There was such an engineer at the Ames Research Center, a National Advisory Committee for Aeronautics facility near San Francisco where researchers were exploring the boundaries of high-speed flight. He was an ebullient, larger-than-life Californian named H. Julian Allen, known to colleagues as Harvey, a nickname taken from the invisible rabbit in the Broadway play. Talking to him, colleagues sensed his agile mind; in conversation he might jump from aerodynamics to Rachmaninoff (an accomplished pianist, Allen would play a piece and challenge friends to guess the composer). He also loved Asian culture, and on a trip to Cambodia's Angkor Wat bought so much furniture that he

> “[Allen] understood what's going to happen when you start going from, say, Mach 1, which the P-51 was approaching in a dive, to Mach 25. He understood what's going to happen when those vehicles go fast.” – JACK BOYD, FELLOW AMES AERODYNAMICIST

Allen at home in 1957: His agile mind jumped from missiles to music to cooking.

had to add a couple of rooms onto his Palo Alto house to contain it. For his dinner guests, who sometimes numbered in the dozens, Allen would cook exotic meals ranging from Scandinavian dishes to Creole gumbos. One colleague recalls his beef bourguignon as “the best I've ever eaten.”

But his true genius was aeronautics. He had helped design the P-51 Mustang, one of World War II's most successful fighters. Before the first sonic booms echoed over Edwards Air Force Base in the Mojave Desert, Allen was thinking about how to break the sound barrier, and by 1952, as chief of the Ames High-Speed Research Division, he was exploring the field of hypersonics—flight at then-unattained speeds above Mach 5. “Harvey was so broad in his ability to think,” remembers fellow Ames aerodynamicist Jack Boyd. “He was always, it seems to me, about five or six years ahead of everybody else.”

As an advisor on the secret ICBM program, Allen was well aware of the warhead reentry problem, and it was exactly the kind of situation where he thrived. “He was very, very strong in aerodynamics,” says Jim Arnold, an aerodynamicist who came to Ames in 1962. “But he also had the breadth to understand the physics that was going on. A lot of aerodynamicists, you start talking about gas processes and the chemical reactions that go on, they just sort of blink, because they really work in a perfect-gas [idealized] world, where those effects are not important. But he understood what's going to happen when you start going from, say, Mach 1, which the P-51 was approaching in a dive, to Mach 25. He understood what's going to happen when those vehicles go fast.”

More than most of his colleagues, Allen was equally at home in the theoretical and the experimental realms. He attacked the reentry problem not with a wind tunnel but with pencil and paper. Having spent several years studying the details of airflow around supersonic jets, he now considered how a reentering warhead would interact with the upper atmosphere. As the warhead slowed down, much of its kinetic energy would be converted into heat. But Allen realized that the very thing that made low-drag shapes an advantage in supersonic flight—a minimum of drag—was a liability in hypersonic flight. The pointed nose generated only a thin shock wave of compressed gas, which provided little protection from the intensely heated air around it; the amount of heat reaching the warhead was far greater than any known material could withstand. The answer, Allen realized, was to slow down the reentry by creating as much drag as possible, which could be accomplished by using a blunt shape. The result would be a thick, free-standing shock wave that would insulate the warhead from most of the heat its deceleration generated.

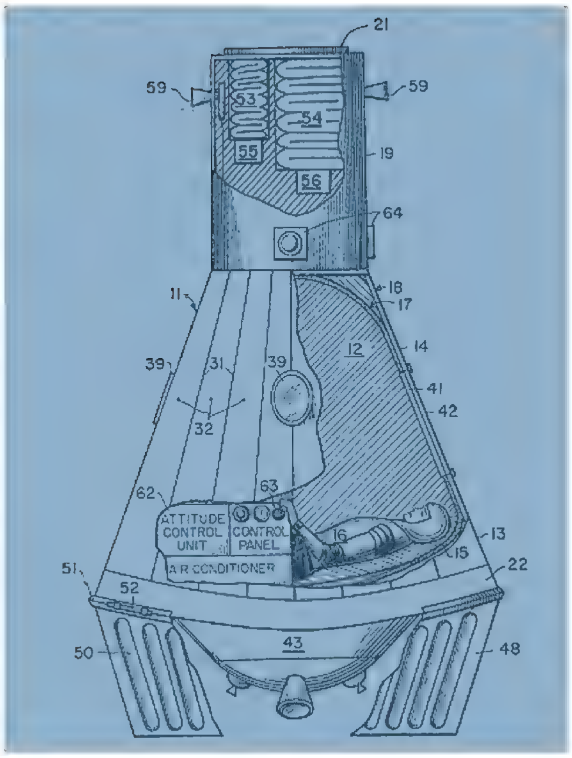
Allen fostered a spirit of collaboration among his people: He would frequently discuss ideas with colleagues over lunch. When the reentry problem came up around the table on one such occasion in 1951, Allen made the surprising suggestion that the right shape might be something resembling a Civil War cannonball. By the summer of 1952, he and Al Eggers, one of his young engineers, were immersed in a mathematical study of the problem. Their results turned conventional wisdom on its head. “Not only should pointed bodies be avoided,” they wrote in a classified 1953 paper, “but the rounded nose should have as large a radius as possible.”

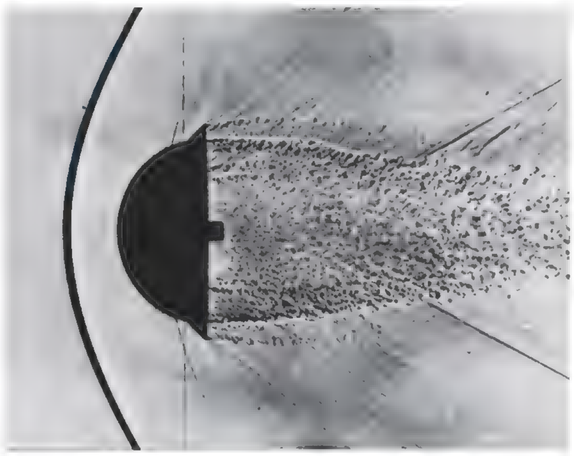
When Allen and Eggers' paper was circulated among missile researchers, the findings were met by intense skepticism. But that didn't faze Allen. “He just thought of it as another hurdle he had to cross,” Boyd recalls, “and it didn't really bother him very much...which I thought was remarkable. He took what criticism he got and what accolades he got sort of the same way: ‘I'm just doing what I want to do.’ ”

By 1955, after extensive testing in wind tunnels, the Air Force had adopted the blunt-body shape for the nose cone of its Atlas ICBM, which was then in development. But it wasn't until 1957, when the 1953 paper was declassified, that the world learned of Harvey Allen's achievement. News coverage hailed Allen's discovery as a stroke of genius. Hugh Dryden, director of the NACA, “ranked the discovery with the development of a smaller hydrogen bomb,” according to the *New York Times*. “He said it had lifted the status of the ballistic missile from a practical impossibility to a virtual certainty.”

Allen downplayed his role in the breakthrough, telling one reporter in 1957, “It's all in the physics book.... All I did was apply known laws.” But his accomplishments still evoke admiration; aviation historian Tom Heppenheimer calls the 1953 treatise “quite probably...the single most important paper ever written in the field of hypersonics.”

In the 1950s, many in the military services were consumed with designs for warheads and missiles, but a small community of engineers was working on human travel outside the atmosphere. In the young field of spaceflight, designers still thought in terms of winged, streamlined





NASA (5)

Pointy shapes (top, left) were still an option for the Mercury spacecraft in August 1958. But when the patent (top, right) was filed a year later, the blunt shape won out. With its thicker shock wave, it was better than a needle-nose rocket at protecting a passenger.

vehicles. By the fall of 1957, in a project with the Air Force, a handful of NACA engineers had designed a rocketplane called the X-15, which was designed to reach speeds up to Mach 7 and altitudes of 50 miles or more—the edge of space. Even though the first X-15 flight was two years away, they were already envisioning a more advanced craft, a hypersonic glider that would launch atop an ICBM on a suborbital trajectory. Everyone assumed this would lead in a slow, incremental way to orbital flight, a milestone that piloted vehicles might not reach for a couple of decades.

In mid-October 1957, the engineers working on the X-15's successor gathered at Ames for the so-called Round Three conference to debate the merits of competing designs for the hypersonic glider. One engineer, a small and wiry man named Max Faget, would make the crucial connection between Harvey Allen's blunt-body concept and human spaceflight.

Faget (pronounced "fah-JAY") came from a family of innovators. In the mid-19th century, his great-grandfather, Jean-Charles Faget, helped save New Orleans from a yellow fever epidemic by discovering a telltale change in body temperature and pulse rate that became known as Faget's Sign. The discovery made it possible for doctors to diagnose victims and isolate them before the disease could spread. In the 1940s, Max's father, Guy Faget, discovered the first successful treatment for leprosy.

Max, in love with airplanes, chose aeronautical engineering. Singularly confident, he never worried about fitting in. In 1946, he arrived for his first job interview at the NACA's Langley Research Center in Virginia wearing shorts, sandals, and a Hawaiian shirt. The center hired him anyway, as much for his guts as his brains; Langley director Robert Gilruth, who went on to head NASA's Manned Spaceflight Center in Houston during the Apollo moon landings, was impressed by Faget's volunteering for submarine duty in World War II. Although his attire became more conventional later—he was fond of bow ties—Faget never lost his streak of individualism. During meetings he might startle colleagues by leaping over chairs (he'd been a gymnast in college) or doing a headstand—to improve the blood flow to his brain, he said. For all his eccentricities, however, Faget's approach to engineering was steadfastly practical. NASA legend Chris Kraft, who saw Faget in action from the space program's earliest days, calls him "as brilliant an engineer as I have ever known, bar none."

At the time Faget and the others arrived at Ames for the Round Three conference, the Soviet Union had just launched Sputnik. All of them realized it was only a matter of time before the Soviets would follow their achievement with a manned spacecraft. To Faget, slow, incremental progress would no longer do; the most important thing was getting Americans into orbit as soon as possible. He knew that wouldn't happen with the kinds of

Al Eggers worked with Allen on the original blunt-body equations. He later became a NASA assistant administrator.

NASM (SI NEG. #00158495)

> “Max made his pitch.... If we wanted to get a man into orbit in a reasonably short period with technology that was available to us, the only reasonable option was the wingless blunt body flying a ballistic trajectory. Max was frustrated that everyone could not immediately seem to see the logic of his proposal.” – NEIL ARMSTRONG

Max Faget was both quirky and brilliant. Years after inventing Mercury's capsule, he helped design the space shuttle.

designs then being considered for the hypersonic glider; reentry heating would do them in. At Ames, Faget crossed paths with Harvey Allen, who described his blunt-body concept. “I bought it right away,” Faget told me in an interview years later (he died in 2004). Back at Langley, he spent the next several months designing a wingless, blunt-body manned vehicle that would reenter on a ballistic path.

When the Round Three participants reconvened at Ames in March 1958, this time to work out a plan for an orbital vehicle, Faget presented his concept. And like Allen before him, he encountered skepticism. True, the X-15, like its planned successors, would reenter the atmosphere with its nose high, presenting its broad underside to the airflow in what was essentially an application of the blunt-body principle. But it was still an airplane, with its flight path controlled by a pilot. Faget was talking about a wingless body whose occupant seemed more like a passenger. But he was completely convinced.

One of those in attendance was a young NACA test pilot named Neil Armstrong, who remembers Faget's bluntness as he addressed the gathering. “Max made his pitch,” Armstrong recalls, “saying with substantial emphasis something to the effect that if we wanted to get a man into orbit in a reasonably short period of time with technology that was available to us, the only reasonable option was the wingless blunt body flying a ballistic trajectory. I think Max was frustrated that everyone could not immediately seem to see the logic of his proposal.”

“It was so obvious,” Faget later recalled. “But believe me, this wasn't an acceptable solution to most of my colleagues. It was anathema. It was a break with the faith.... But it was the right way to do it.” What Faget loved about the design was its simplicity. For the astronaut to return to Earth, only one event—firing the retro-rockets in the right direction to slow down the craft so it could fall out of orbit—need happen. From then on, a broad, gently curving heat shield would face into the direction of flight, slowing the craft until it was in the lower atmosphere, when

NASA AMES

NASA LANGLEY RESEARCH CENTER

Above: a gun-like wind tunnel invented by Harvey Allen for supersonic testing. Left: “Little Joe” capsules were the precursors of Alan Shepard's Mercury spacecraft.

it would deploy a parachute for landing.

Throughout the spring and summer of 1958, Faget continued to refine the concept for the ballistic craft, which came to be known as "the capsule." Longtime collaborator Caldwell Johnson refined Faget's ideas in superb engineering drawings; other colleagues performed wind tunnel tests on candidate shapes. To minimize heating, they found, the heat shield should possess a radius of curvature 1.5 times its diameter. Other tests showed that if the capsule itself were shaped like a truncated cone, it would automatically right itself during reentry, even if the onboard control system failed, an event Faget considered likely. Another concern raised during the Ames conference was that ballistic reentry would be associated with high G-forces. In response, Faget invented a form-fitting "survival couch" to help pilots withstand the crushing deceleration. When volunteers rode the contour couch in a Navy centrifuge, they endured more than 20 Gs. Faget knew the problem had been solved.

Ultimately, one characteristic of the ballistic vehicle clinched its selection: It was lightweight enough to be launched by the Atlas missile, whose payload capacity was 2,000 pounds. (The orbital version of the X-15 would have required a launcher more powerful than anything in existence.) By the end of 1958, NACA had become NASA, and Faget's capsule had been chosen for the agency's new effort, now christened Project Mercury.

The Mercury spacecraft went on to put the first Americans in orbit—but not before Soviet cosmonaut Yuri Gagarin, riding in a craft called Vostok, got there first. Taking advantage of the greater payload capacity of their R7 booster, the Soviets gave Vostok a spherical shape, like Harvey Allen's cannonball, so there was even less worry about controlling its orientation during reentry. But Faget's gently curved heat shield showed up in the next-generation Soviet spacecraft, called Soyuz—just as it did in Gemini and Apollo. Even the space shuttle, the first winged spacecraft, reentered in the nose-high attitude of the X-15, using a modified blunt-body approach along with advanced insulating tiles to save its skin from the heat of reentry. And today, as the shuttle era draws to a close, NASA's newest manned vehicle, Orion, is back to the "capsule" shape—proving once again that when it comes to spaceflight, blunt is beautiful.

The 1958 launch of a Mark II nose cone (below) on an Atlas B missile gave real-world proof of Allen's breakthrough ideas.

AMERICAN AERO

NASA

THE BOOK *of Hours*

FORGET HANGAR TALES. LOGBOOKS TELL THE REAL STORY. BY TOM LeCOMPTE

PHOTOGRAPHS BY ERIC LONG

Lieutenant Benjamin Foulois' log of flying the U.S. Army's first airplane is in the Library of Congress. Charles Lindbergh (opposite) would not be so lucky: In 1927, souvenir hunters stole the logbook of his history-making New York-to-Paris flight.

ON DECEMBER 23, 1986, after more than nine days of dodging storms, battling fatigue, troubleshooting mechanical problems, and worrying whether he and copilot Jeana Yeager would have enough fuel to make it home, pilot Dick Rutan gently guided the twin-engine *Voyager* onto the runway at Edwards Air Force Base in California. They had just completed the first nonstop flight around the globe without refueling, and thousands of well-wishers were on hand to cheer their accomplishment. After shutting down the engines and securing the aircraft, Rutan had one more thing to do before he could take his first shower in more than a week. Handed a slender, rectangular book, Rutan opened it and began filling in the blocks across the double-page spread.

Date: "Dec. 14–23."

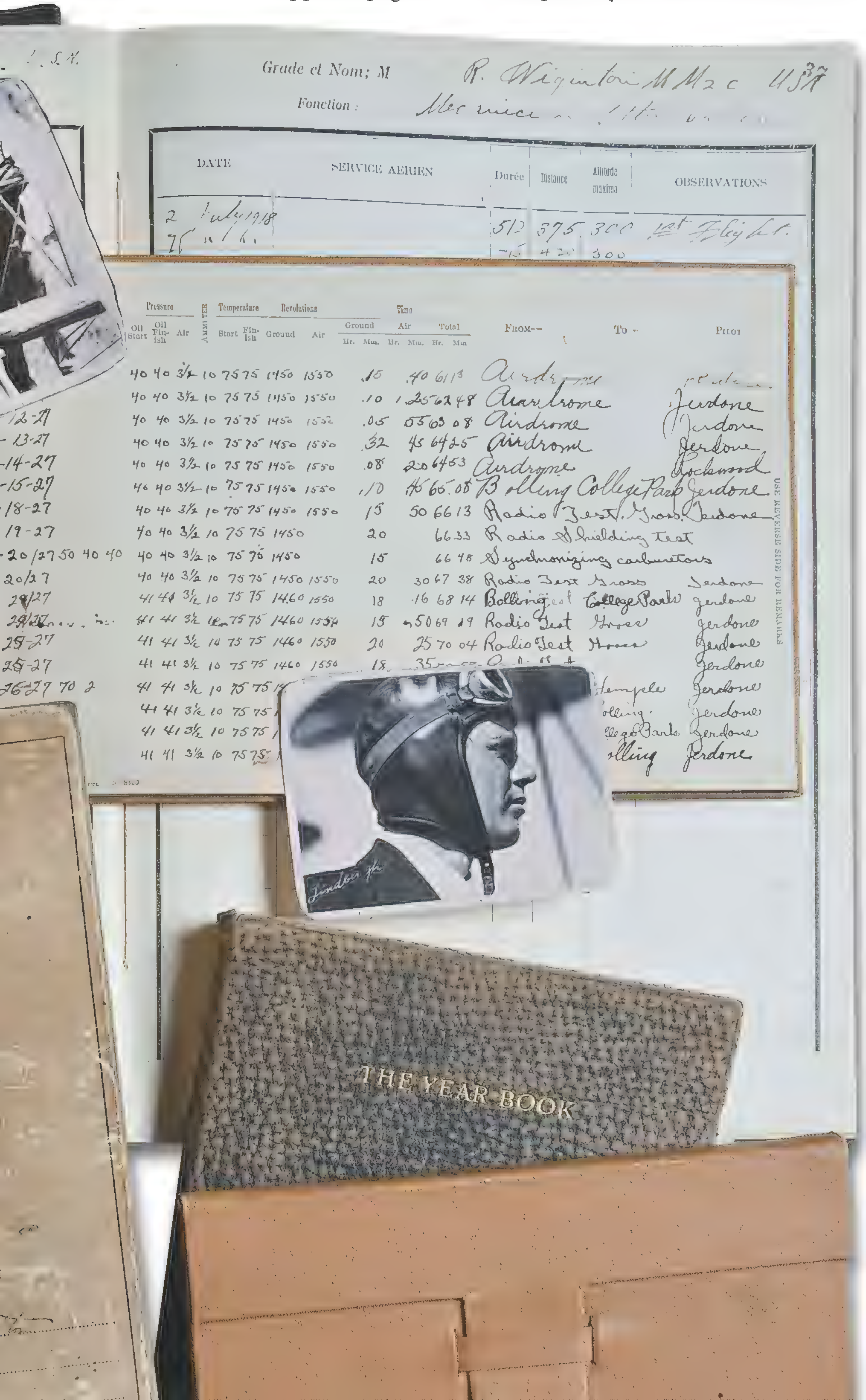
Aircraft Make and Model: "Voyager."

Total Duration of Flight: "216.3."

And so on. In a small space reserved for "Remarks," Rutan wrote: "World Flight." He then added a little flourish: a smiley face.

Flight logs have been around as long as aviation itself. The Wright brothers kept detailed notebooks, recording dispassionately the results of their experiments in building the first airplane. After his landmark flight on December 17, 1903, Orville wrote: "The machine lifted from the truck just as it was entering on the fourth rail. Mr. Daniels took a picture just as it left the tracks."

Nine years later, pilots of Britain's Royal Flying Corps (the precursor to the Royal Air Force) were using logbooks routinely. Unlike the free-form pages the Wrights used, the new books' pages were divided into rows and columns, their format borrowed from ship's logs, which had been in use for more than a century. In a logbook from 1913, a pilot penned on one page the date of a flight, airplane used, passenger's name, time aloft, and course flown. On the opposite page, he recorded height achieved, distance, weather, and remarks. The entries show the limitations of the technology. The airplanes were slow, unreliable, and capable of carrying only light loads (thus the singular "passenger") and flying only short lengths (thus "course" and "distance," versus "route" and "destination"). In 1913, there were no stamps or endorsements indicating that such logs were mandated by higher-ups. The purpose of the logs was to document the capability of the aircraft as much as that of the pilot. At this point in aviation history, all pilots were essentially test pilots.



Logbooks also became an important component of civil aviation. In the United States, barnstormers, airline pilots, and airmail carriers all kept logs, in many cases simply to make sure they were properly paid. The Air Commerce Act of 1926, which set forth the first regulations governing the certification of aircraft and licensing of pilots, also made flight logs a requirement. In addition to setting down the rules and basic format of a pilot's log, the act required logbooks to be regularly certified. The law also mandated logs recording the maintenance of individual aircraft. Before this, maintaining aircraft generally fell to the pilots who flew them. But as the technology became more complex and maintenance became more specialized, logs were deemed necessary to document an individual aircraft's mechanical history and airworthiness.

The Civil Aeronautics Administration in 1940 relaxed the rules governing pilots' logs. The new rules mandated that pilots keep only a "record of the flight time used to substantiate recent experience or qualifications for certification or ratings." No verification was necessary; when it came to logging most of their flight hours, pilots were on an honor system. Airlines considering a new hire first looked at a pilot's total hours, generally requiring a minimum of around 1,500, so the rules became an invitation to lie. The practice of padding a logbook with "P-51 time" (so-called for a popular pen, the Parker 51) became a well-known, if seldom admitted, practice. Though the consequences of getting caught are serious (falsifying a pilot's log is a federal offense), "it probably happens more than you realize," says Barry Schiff, a retired TWA pilot and aviation writer. In most cases, he says, the culprits are never caught unless an incident prompts a closer look. Investigators can sometimes check the accuracy of a log by cross-referencing it with records kept by insurance companies, airport operators, and air traffic control.

Many professional pilots cease recording their hours as soon as they get their pilot's rating. "There's no reason," says retired Air Force colonel Leonard L. Griggs, who quit keeping a pilot's log soon after getting his wings in the early 1960s. A pilot in Viet-

INSET PHOTOS: LEFT: NASM (SI-A-43519-G); RIGHT: NASM (SI-89-10-A)

nam who went on to a career at the Federal Aviation Administration and a job as head of Lambert-St. Louis International Airport in Missouri, Griggs says he let his bosses track his cockpit hours. Keeping a logbook, he says, was a useless chore. Besides, "nobody corroborates them. It's like reporting your golf score."

Nevertheless, says Schiff, most pilots do maintain a personal log, often simply as a habit from their student pilot days. The books also become a kind of diary. "Flying has been the centerpiece of my life since I was 14," says Schiff. "My first logbook begins in 1952, and I wouldn't [risk taking] it anywhere. It's a treasure."

Though most pilots stick with the standard flight log, a few get creative, squeezing in expanded descriptions of a particular flight or even building elaborate scrapbooks to document their flying histories. "I've run into some international pilots who pasted into their logbooks stamps or coins from every country they visited," says Schiff. Whether they detail a single flight, an entire career, or even the history of an individual airplane, logbooks are a part of the history and culture of flying.

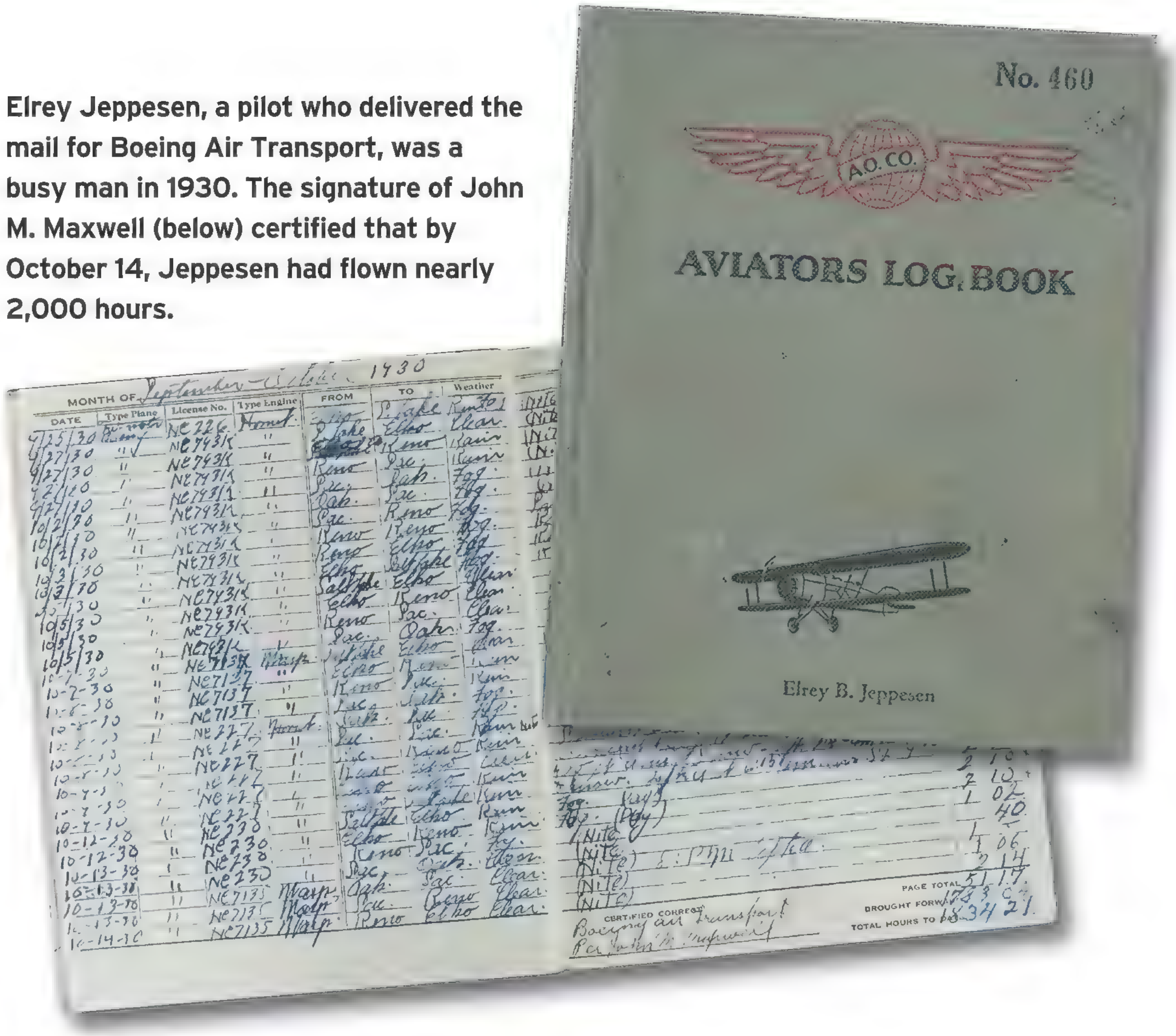
Benjamin Foulois

Lieutenant Benjamin D. Foulois, a pilot with the U.S. Army Signal Corps, documented his test flights of the U.S. Army's only airplane in 1909 (a Wright Model B) in a thin, leather-bound notebook labeled "Log—Airplane No. 1." The March 12, 1910 entry reads:

"Made 5 perfect flights, lasting 8 min 25 sec, 15 [min] 10 sec, 4 min 10 sec, 12 min 10 sec, & 16 min respectively. During the 4th flight Lt. Foulois made a large detour of about 1 mile from the aero field, circling the building at the Lower Post. The machine was under perfect control at all times and landings were excellent."

The handwritten log covers February 1910 to July 1911, records Foulois' trials in getting the airplane assembled and ready for flight, and describes the details of his 64 flights, as well as his many frustrations with weather delays, breakdowns, and frequent mishaps. Total time in the air: Nine hours and 10 minutes. Foulois' tests went a long way in convincing the Signal Corps and Congress of the need to develop an aviation industry. Foulois went on to become a major general and chief of the Army Air Corps from 1931 to 1935.

Elrey Jeppesen, a pilot who delivered the mail for Boeing Air Transport, was a busy man in 1930. The signature of John M. Maxwell (below) certified that by October 14, Jeppesen had flown nearly 2,000 hours.



Charles Lindbergh

Immediately after Charles Lindbergh landed outside Paris on May 21, 1927, having made the first nonstop transatlantic solo flight, his airplane was swarmed. "Within seconds my open windows were blocked with faces," he wrote in his 1953 memoir of the flight, *The Spirit of St. Louis*. "I could feel the Spirit of St. Louis tremble with the pressure of the crowd." As Lindbergh was pulled from the cockpit and lifted above the mob at Le Bourget airfield, he "heard the crack of wood...and there was the sound of tearing fabric." He was afraid—not for himself, but for his airplane.

Carried to safety, Lindbergh later learned that someone had stolen, among other things, his logbook. It was never recovered. "That was a devastating thing for him," says Erik Lindbergh, Lindbergh's grandson. To write his memoir, Lindbergh had to re-create the flight from memory. "You know, memory is a funny thing," says Erik. "After spending 33 hours in a plane, it would be hard just to recall all the parts of the flight." The loss was a personal one for Lindbergh, and even greater for aviation history.

Elrey Jeppesen

The year was 1930. Twenty-three-year-old pilot Elrey Jeppesen had just been hired by Boeing Air Transport (later to become United Air Lines) to fly the mail between stops in Nevada, Utah, Nebraska, and Wyoming at a rate of $50 per week plus 14 cents per mile. With only Rand McNally road maps, airmail pilots navigated by flying low enough to follow such landmarks as roads, rivers, and railroad tracks. Pressure to deliver the mail on time, no matter the weather, forced pilots to fly in extremely dangerous conditions. That first winter, four of the 18 pilots flying the

mail on Boeing's western routes were killed (see "Airmail Odyssey: 1918–2008" at *www.airspacemag.com*).

Jeppesen started taking notes on the routes. In a small, black, looseleaf notebook, he recorded field lengths, slopes, drainage patterns, and details on lights and obstacles. He also included drawings of terrain and airport layouts and of the location of pastures he could use in an emergency, along with the phone numbers of sheriffs and ranchers who could provide weather reports. Jeppesen's fellow airmail pilots soon noticed that while they were stuck on the ground waiting out the weather, Jeppesen was somehow getting through. They started asking him if they could get a copy of his notes. After enough requests, Jeppesen recognized a business opportunity, and in 1934, he started selling copies for $10 apiece, beginning an aviation chart business that now brings in $120 million a year.

"I didn't really think much about a system or publishing it," Jeppesen said in a 1992 interview with *IFR* magazine. "I really did it just to save my own hide."

Chuck Yeager

For years, the sound barrier had been considered a wall that could not be penetrated. Breaking it, wrote U.S. Air Force test pilot Chuck Yeager in his 1986 autobiography *Yeager*, would be a leap into the "Ughknown." What would happen when he tried to make that leap in the rocket-powered Bell X-1? Would the aircraft shake so violently it would break apart?

Yeager made a series of flights in which he nudged the X-1 closer and closer to the barrier. On October 14, 1947, he was ready to attempt to push past Mach 1. At more than 20,000 feet, he and the X-1 dropped from a Boeing B-29 mothership. After stabilizing his aircraft, Yeager activated the four-chamber rocket engine and the X-1 shot upward. At 36,000 feet, he cut two of the rocket chambers. Leveling off at 42,000 feet, he fired another chamber and the X-1 surged to .96 Mach, then .965. As the aircraft increased in speed, the ride smoothed out. "Grandma could be sitting up there sipping lemonade," Yeager wrote in his autobiography. Far below in the desert valley, a sonic boom confirmed that he had indeed broken the sound barrier, and it was later calculated that Yeager had reached Mach 1.06.

After the history-making flight, Yeager updated his logbook with a succinct entry: "ok."

James Edgerton

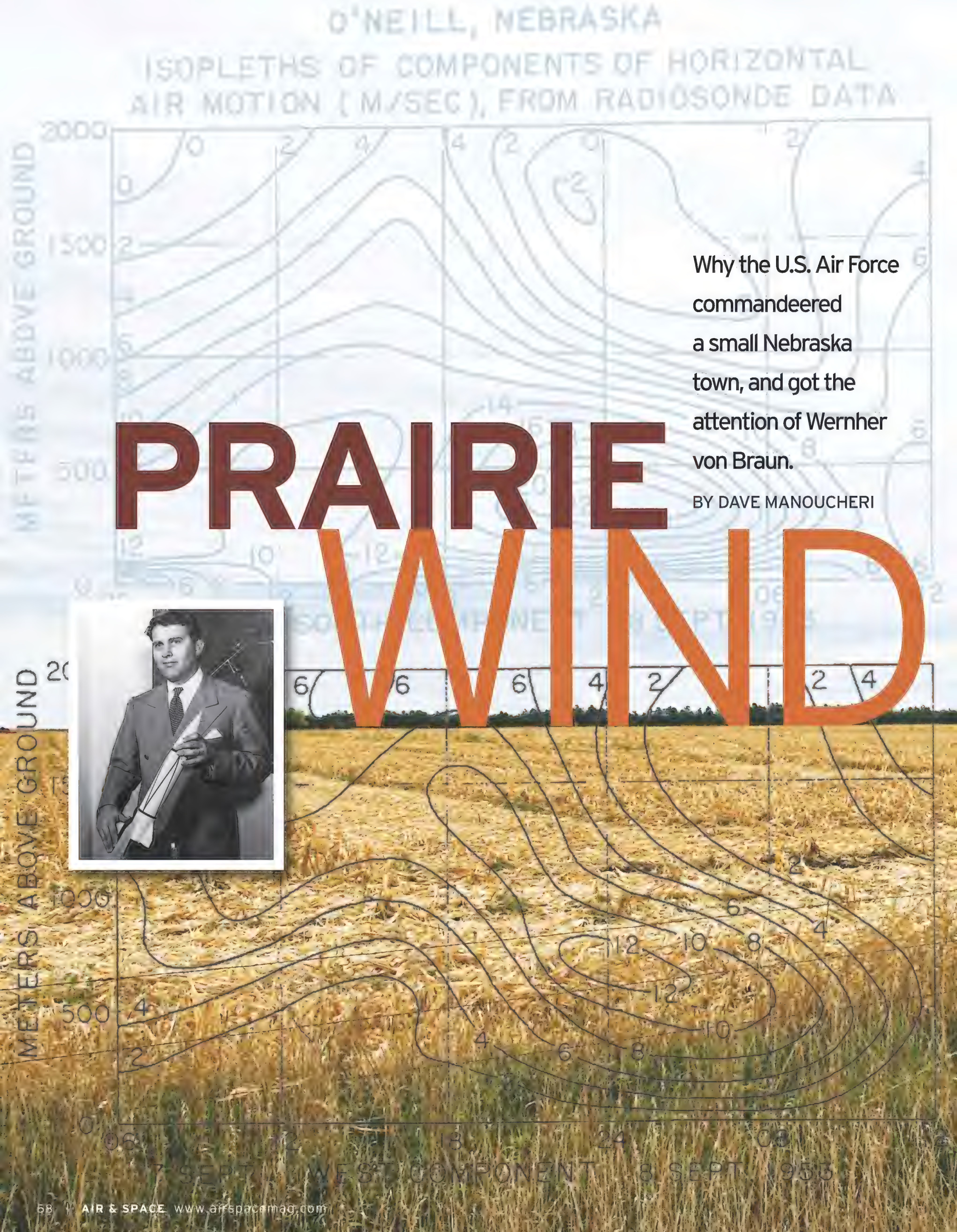
On March 1, 1918, prodded in part by the banking industry, which wanted to cut the "float" time for checks sent from one city to another, Congress appropriated $100,000 to start airmail service between New York, Philadelphia, and Washington, D.C., with U.S. Army pilots and airplanes doing the flying.

Things got off to a rocky start when the pilot flying the inaugural run from Washington, D.C., to Philadelphia on May 15 got lost in a fog and crash-landed in a Maryland pasture. The crash delayed the departure of Lieutenant James C. Edgerton, assigned to the first flight of the Philadelphia-Washington, D.C. leg. According to Edgerton's logbook, he flew a Curtiss Jenny trainer, taking off at 1:14 that afternoon from Bustleton Field and arriving in Washington, D.C., at 2:50 p.m. The Jenny, he noted in his log, has a "tendency to fly to left and [be] a little nose heavy," and because "too much oil" had been put into the engine, "during the first hour of flight" oil was flung over both airplane and pilot. Other than that mess, the flight was uneventful.

According to his logbook, Edgerton made 52 airmail trips for a total of 7,155 miles, with only one forced landing.

Chuck Yeager preferred to let his flying do the talking: After his sound-barrier-busting flight on October 14, 1947, his only logged comment was "ok" (above).

INSET PHOTO: USAF



PRAIRIE WIND

Why the U.S. Air Force commandeered a small Nebraska town, and got the attention of Wernher von Braun.

BY DAVE MANOUCHERI

JIM RYAN WAS ONLY 15 at the time, but he remembers his father's negotiations in the spring of 1952 to rent the U.S. government some land six miles outside O'Neill, Nebraska. It wasn't so much the military's plan to conduct experiments there that stick in his mind; it was the tall German-born scientist heading the advance team, who took the time to shake the boy's hand. Wernher von Braun was memorable, Ryan recalls, because everybody, from the two German scientists with him to the researchers who came later, seemed to defer to him. Von Braun commanded the attention of everyone in the room, including Ryan's father Neil, who, as an influential businessman and prominent landowner, was an imposing figure himself.

The land deal was for an Air Force project to study the air, and not von Braun's experiment. Jim found it odd, then, that what was about to happen in O'Neill was important enough to get the famous rocket scientist involved. "He wanted to stop in and see what the hell was going on," says Ryan. The teenager was an airplane enthusiast, so he had read about von Braun (and the next year bought a Piper J-2 Cub for $300) and had an inkling of the importance of the tests, "because of what these guys talked about, coming in and out of my dad's offices.... I remember von Braun's whole manner. He was definitely in charge without yelling and screaming. He was very impressive, one of a kind. I knew I was shaking hands with somebody great."

What Ryan didn't know was that von Braun had been trying to conduct this very experiment since World War II. His V-2 rocket had failed as a weapon for the Nazis, and one reason, along with problems in the guidance system, was air movements near the ground that kept the flying bombs from hitting their targets. Scientists had no idea how the air behaved from the ground up to about 5,000 feet. Almost 10 years later, they were no closer to answers.

Accompanying von Braun in the land negotiations were two former countrymen: meteorologist Heinz Lettau, in charge of the Air Force project, and ballistics expert Guenter Loeser, who, like von Braun, had been brought to the United States after World War II as part of Operation Paperclip to augment U.S. research. Lettau and Loeser now worked for a new division of the Air Force called the Geophysics Research Directorate, based in Cambridge, Massachusetts, while von Braun worked for the Army. Lettau and Loeser were looking at the O'Neill test to further the science of rocketry, but the resulting data would end up proving helpful to aviation, agriculture, and even weather forecasting.

Von Braun's priority at the time was to put a man in space; the directorate's was far different. The Air Force faced a serious problem: Planners wanted to add guided missiles to the service's fleet of fighters and bombers, but scientists had no idea how low-level atmospheric conditions might affect the missiles' trajectories or even whether the missiles could hit their targets. Changes in wind and air pressure in the first mile of atmosphere could also have a detrimental effect on the performance of new jets the Air Force was testing. To understand how air near the ground behaved—how it circulated, how it warmed and cooled—the Air Force was taking temperature and barometric readings every few hours at base runways. Lettau was called in to figure things out. If successful, his experiment would give the Air Force standards it could follow without continually having to take runway readings.

OPPOSITE INSET: NASM (SI 76-13637); BACKGROUND: DAVID MANOUCHERI ; INSET: COURTESY HOLT COUNTY INDEPENDENT

Field of dreams: In 1953, researchers hoping to understand low-altitude winds turned the Great Plains into a laboratory. Based in O'Neill, Nebraska, Air Force scientists (left) collected data (background; detail from the report) that helped Wernher von Braun (opposite) and others develop missiles.

Air Force technicians (below) were sent to O'Neill to set up communications with the Geophysics Research Directorate in Massachusetts, which ran the experiment. Wally Wimmer (standing, third from right) returned to the town to retire.


UPPER AIR
LABORATORY

√ ATMOSPHERIC RADIATION

√ ATMOSPHERIC ENERGY

√ ROCKET INSTRUMENTATION

The teams in this laboratory are concerned with problems of gathering useful data from extremely high atmospheric levels. By use of high-altitude rockets, these men investigate the composition, structure, electrical properties, and radiative energy processes of the outer atmosphere. The instrumentation research teams develop the sturdy, yet sensitive instruments vital to the recording and transmitting of needed data.

Final instrument checks are made by the field team before assembling and launching this rocket.

A 1950s directorate brochure touted upper air research. Right: Townsfolk got to inspect a radar dish on "open house" day.

A quiet, conservative man who always dressed in a sport coat and bow tie, Lettau had been trying to map air movements since the 1930s, when he was with the German Weather Bureau. Now working for the geophysics directorate, he received data from more than a dozen universities across the country. But hundreds, sometimes thousands of miles separated the schools, with different types of land and air at each. He finally convinced the Air Force that the only way to accurately study and predict air movements was to bring all the university minds to one place and use the outdoors as a giant laboratory. He needed somewhere flat, with a near-constant breeze, and a community nearby to help support and house the scientists.

"The time was just right for this," Lettau told me, not long before his death in 2005. "Such new possibilities for warfare had opened up. Most of these new types of warfare were relying in some way on atmospheric effects. Basically, they had always to rely on the same meteorological elements: that's the wind distribution at the ground. So my argument with the Air Force was that in order to really get the full benefit of all of this [university] contract work, [you have to] bring all these people together with the equipment to see how the basic terms...agree with each other."

In Lettau's mind, the Air Force needed two things: first, to be able to accurately guide a missile to its target, and second, to understand how radiation from a nuclear strike would move in low-level winds.

After scouring daily reports from the National Weather Service's field offices, Lettau settled on the little town of O'Neill, where the prairie wind blew southward at a near-constant rate.

BEFORE THE EXPERIMENT BEGAN, say longtime residents, Neil Ryan's site was dotted with cornfields and cows; when I visited 55 years later, it looked much the same. Gravel roads are still the only route to the field. The base camp and major experiments took up about 11,000 square feet of land, while the monitoring and testing stretched for a 1.5-mile radius. Ryan also owned an office building in town, and the scientists used that for workspace and to house a small wind tunnel for calibrating equipment.

O'Neill had a population of only about 4,000, with an economy based on farming. But the town served as a transportation hub for northeastern Nebraska, with a railroad depot and two highways, 20 and 281, that converged in the middle of town, at the main street's only stoplight. That made it convenient to ship in tons of equipment. O'Neill also had one large hotel, the Golden, in its center, and a couple of smaller motels. The directorate had already anticipated taking every vacant room, but an invasion of Air Force personnel would need a lot of support and help from the residents. Knowing the team would have to win over the town, Guenter Loeser returned to O'Neill early in 1953.

Like von Braun, Loeser had a way with people, and he spent a couple weeks talking to O'Neill's leaders and businessmen to enlist their help. He visited the town's two newspapers, the *Frontier* and the *Holt County Independent*, to get the word out about the project and recruit workers. Residents took a liking to him immediately. The flamboyant German scientist seemed the polar opposite of the reserved Lettau. Loeser, who liked to wear a beret, was outgoing and talkative, and willing to place bets with anyone that the United States would put a man on the moon in the next 20 years.

To inform the town of the directorate's intentions, Loeser wrote a press release that ran in both newspapers, explaining that the wind experiment "will be necessary for the use of guided missiles."

Starting in late spring, members of the Air Force and their university partners began streaming into town. Many, including Lettau, brought their families. "The O'Neill Chamber of Commerce is badly in need of more housing for the Air

LEFT: COURTESY WALLY WIMMER; TOP: COURTESY ESC HISTORY OFFICE, HANSCOM AIR FORCE BASE; RIGHT: COURTESY HOLT COUNTY INDEPENDENT

Force men and scientists," the *Independent* reported on July 9. "It is imperative that more rooms be made available to these men. The number now has been set at 180 men." O'Neill's residents rushed to help. Spare bedrooms were opened up. Garages became apartments.

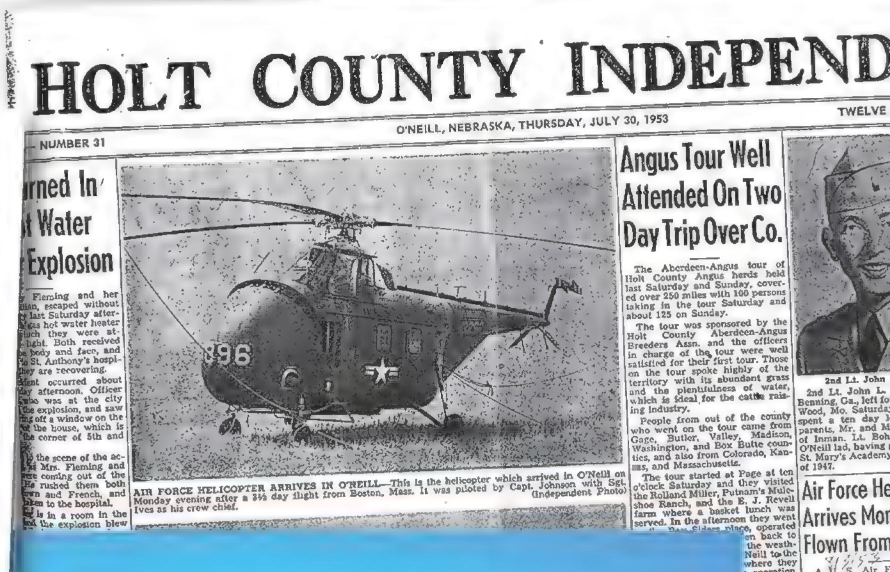
"The biggest thing was: Where do you put them up?" says Jim Ryan, now retired in McDonough, Georgia. "These people were from Boston and New York, all over the country. They were really taken aback by how friendly everybody was. If they'd needed your car, we probably would have let them use it. It really kind of blew them away. They were fantastic people. We really enjoyed them and they really enjoyed us. It was like going to the zoo, I guess. Them and us looking at each other. What was interesting to me wasn't the wind tracking, but the people. They added another dimension to the whole zoo."

Soon after the visitors were settled, the equipment began to arrive. One shipment, from Offutt Air Force Base in Nebraska, contained nearly five tons of gear. Fifteen institutions were committed to the tests, including Argonne National Laboratory, the Air Force Cambridge Research Institute, and universities from Maryland to California. Each brought its own equipment. Iowa State College even hauled in a computer to help process the data; it filled an entire room.

By most accounts, the scientists loved the location. Ryan's prairie field gave them the perfect test site, and the town supported their efforts. Air Force officers felt differently. Some were on the field all day long, and the landscape wore on them. Without trees or other obstacles on the site, wind raked through so strongly that even the grass bent sideways. They began calling it, derisively, the "flattest piece of land in the free world." Project engineers erected 50-foot-tall towers around the field to hold sensors and anemometers, instruments that gauged the strength of the wind by catching it in what looked like ping-pong balls cut in half and fixed to small, horizontal windmills.

Those in the rank and file were happy in O'Neill. Former airman Wally Wimmer, for one, was thrilled with the assignment—and ended up returning to the town half a century later to retire. Wimmer was part of an Air Force communications wing sent in to keep channels open between O'Neill and the directorate headquarters in Massachusetts. "They gave us a per diem to go off base," he told me as we gazed at the field. With the extra money, the Air Force men spent freely at night in the town's bars and American Legion hall. Wimmer and his crew lived in nearby homes, so they had no housing costs, and meals were usually thrown in. The men might eat in town, only to come home and find a full dinner waiting for them. "We also got activation pay for being taken away from our homes," he says, making duty in O'Neill financially rewarding.

By mid-July, the test site had become a self-contained community, with sleeping quarters, a fire department, and medical facilities. It had fresh water as part of the lease with the Ryan family, whose ranch was on adjacent land. The site even had its own electrical grid, which, when powered up for the first time, caused some confusion in town. "There are 115 lights in a string which is about seven-tenths of a mile in length," the *Independent* reported. "Seen from a distance, the lights looked a great deal like a prairie fire." The military gave the experiment an official title—The Great Plains Turbulence Field Project—and a budget of $1 million (the equivalent of about $7 million today). "They really didn't explain to us what it would accomplish or what the purpose was," Wimmer says. "All we



HOLT COUNTY INDEPEND

O'NEILL, NEBRASKA, THURSDAY, JULY 30, 1953

NUMBER 31

TWELVE

...rned In ...t Water ...Explosion

AIR FORCE HELICOPTER ARRIVES IN O'NEILL—This is the helicopter which arrived in O'Neill on Monday evening after a 3½ day flight from Boston, Mass. It was piloted by Capt. Johnson with Sgt. Ives as his crew chief. (Independent Photo)

Angus Tour Well Attended On Two Day Trip Over Co.

The Aberdeen-Angus tour of Holt County Angus herds held last Saturday and Sunday, covered over 250 miles with 100 persons taking in the tour Saturday and about 125 on Sunday.

The tour was sponsored by the Holt County Aberdeen-Angus Breeders Assn. and the officers in charge of the tour were well satisfied for their first tour. Those on the tour spoke highly of the territory with its abundant grass and the plentifulness of water, which is ideal for the cattle raising industry.

People from out of the county who went on the tour came from Gage, Butler, Valley, Madison, Washington, and Box Butte counties, and also from Colorado, Kansas, and Massachusetts.

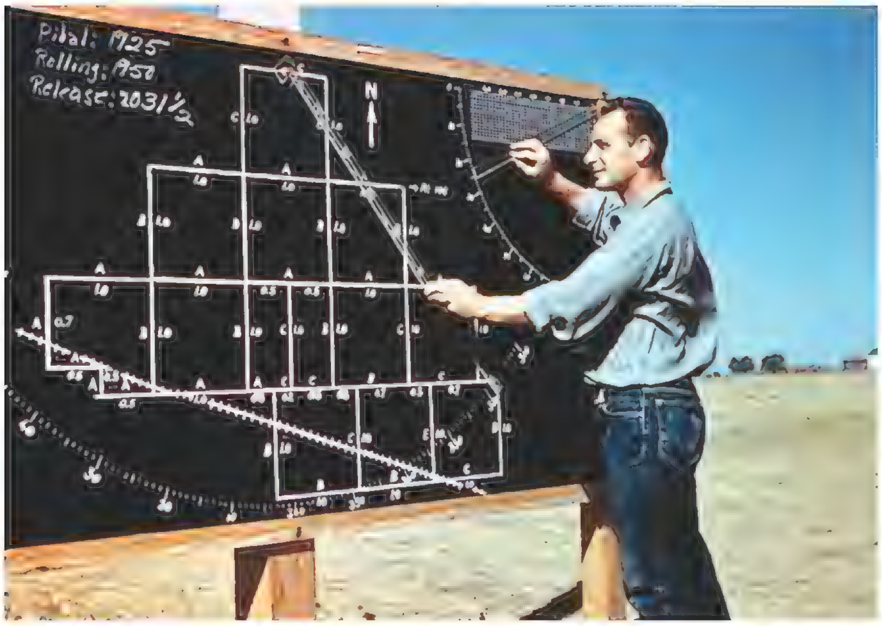
The tour started at Page at ten o'clock Saturday and they visited the Rolland Miller, Putnam's Muleshoe Ranch, and the E. J. Revell farm where a basket lunch was served. In the afternoon they went ...

2nd Lt. John ...

Air Force He... Arrives Mor... Flown From...

The arrival of a Sikorsky H-19 was a big day for the program — project leader Heinz Lettau's wife Katharina and sons Ulrich (in front seat) and Ludwig (in back) saw it at the open house. Locals called it the "flying windmill." Tragically, it crashed before the tests began, killing Lettau's fellow scientist Guenter Loeser.

TOP LEFT: COURTESY HOLT COUNTY INDEPENDENT; TOP RIGHT: HOLT COUNTY INDEPENDENT; BOTTOM: COURTESY LETTAU FAMILY



COURTESY LETTAU FAMILY

knew was that it was a wind turbulence program of study from zero to 5,000 feet."

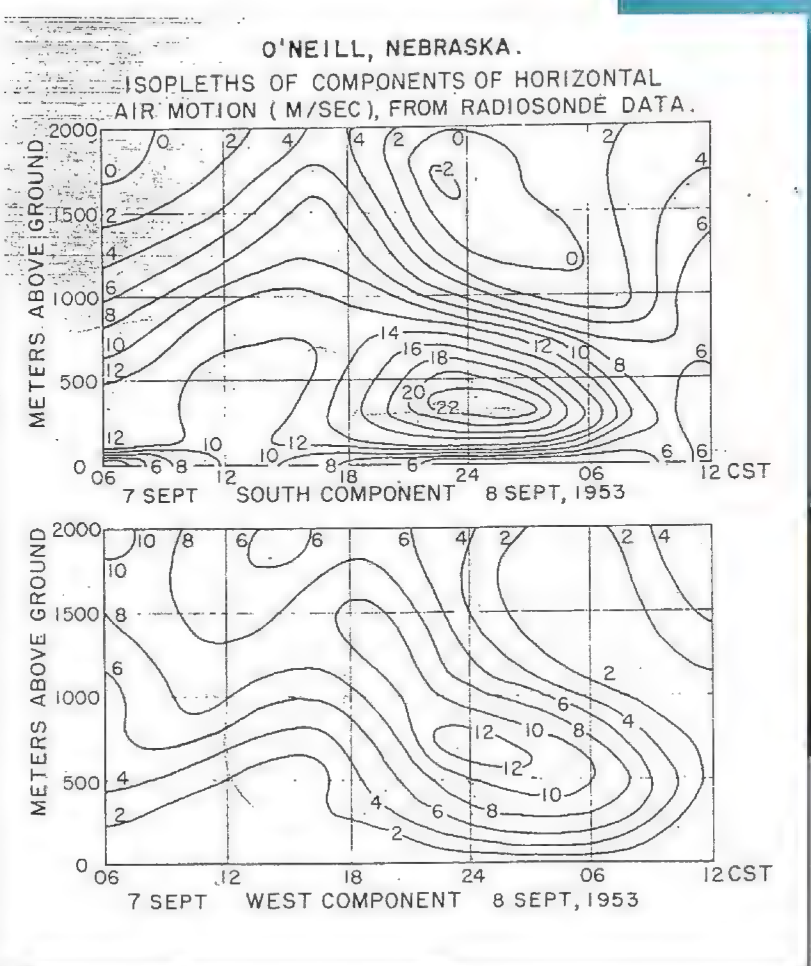
Later that month, the Air Force flew in a Sikorsky H-19 Chickasaw helicopter from Massachusetts that would be critical to a testing technique Loeser had developed. The chopper was to hover at 5,000 feet and drop a rack filled with small explosives that would go off at various times, making puffs of smoke in a vertical line on the way down. A camera on the ground would photograph what effect, if any, the wind had on the smoke. Loeser was anxious to begin his experiment, but he had hit a snag. The pilot had inspected the helicopter upon arrival and found a problem with one of its blades. Undaunted, Loeser asked the Air Force personnel to try a test run. He wouldn't go at full altitude or speed, but he wanted to make sure that the crew got trained for the mission. It was a terrible mistake.

The helicopter wasn't in the air long when Wimmer saw it was having trouble. As the H-19 circled, he saw a blade come off, sail backward, and smash into the tail rotor, causing the chopper to crash. Wimmer and a fellow airman grabbed a jeep and barreled through a barbed wire fence to get to the wreckage. They pulled out the pilot and copilot; both were dead. As Wimmer reached the back of the chopper, the explosives in the rack started to detonate. With shrapnel flying everywhere, all he could do was flee and watch the chopper burn with the 39-year-old Loeser and three airmen inside.

The team was devastated. The man who had done so much to set the stage for the experiment was dead. He would never see the results of his technique, nor collect on all the moon bets he'd made (Loeser had been right: Apollo 11 landed on the moon 16 years later).

The crash was still under investigation when the Air Force brought in a new helicopter and personnel. Testing started as scheduled on August 1. And once it began, it was constant. For evening tests, the directorate hired 12 local high school students to launch balloons. Jim Ryan was one of them. The first week the students counted how many steps they took in a mile; the count was necessary to space the balloon releases accurately. Each evening, the students took weather balloons with high-intensity light bulbs attached and walked until they were spaced about a quarter-mile apart over a three-mile stretch. Then they released the balloons at various intervals, and cameras photographed the lights in the sky. The paths of the balloons showed movements of the air. "In early afternoon, the Air Force bus would come into O'Neill and pick us up," Ryan recalls. "I worked the tests every night for a month."

Lyle Fox, who worked with Ryan launching the balloons, remembers the goal was to try to get two experiments in every night. Fox, who still lives in O'Neill, recalls the difficulty of walking through the



LEFT: COURTESY ESC HISTORY OFFICE, HANSCOM AIR FORCE BASE; RIGHT: COURTESY LETTAU FAMILY

A scientist records test results (top), which included data obtained from balloons (above). Lettau sent diagrams of air movements to the directorate, which compiled the information in a report that was classified until the late 1960s.

thick prairie grass at night, blinded by the bright light attached to the balloon. "You might run into a cow, or scare up a pheasant," he says. "They won't fly away until you're almost on top of them, and it's enough to make your heart stop."

More than once, Ryan recalls, the pheasants caused a delay in the tests. "Once in a while a boy would get the daylights scared out of him and let go of the balloon," he says. "You'd hear the scientists yelling to stop the balloon launch or shouting at the kids because launching it early would stop the whole test."

On the communications side, "it got to be hairy sometimes because you had to have a 24-hour-a-day communications guarantee," says Wimmer, "because they worked all the different hours, because weather conditions would change, and they wanted everything on the test they could have, and every weather condition they could encounter."

The testing ended after five weeks, on September 8. While it had taken months to negotiate, prepare, and build up the site, tearing it down was quick work.

THE AIR FORCE TOOK nearly four years to analyze the reams of data collected in O'Neill, compile them, and publish the results. The two-volume report was entitled *Exploring the Atmosphere's First Mile*, and was classified until 1969. The first volume is dedicated to Loeser and the airmen killed in the helicopter crash.

It turned out that the airborne test Loeser developed gave the scientists their most significant discovery. The puffs of smoke had revealed a sharply defined layer of wind, with a maximum speed of 55 mph, at about 1,200 feet (at ground level the air moves only modestly, and from 4,000 feet and up it is fully calm). In essence, the scientists had discovered the existence of a low-level jet stream that Lettau described as being like a sheet or a wall that was far different from the fluid movements of the jet stream in Earth's upper atmosphere. "This, of course, was one of the major successes," Lettau told me. "What we found about the low-level jet stream in the O'Neill experiment is unsurpassed because of the Loeser technique." Scientists now had a method by which they could measure and analyze air movement near missile test sites, he said.

The results from O'Neill were the benchmark for low-altitude atmospheric science for 15 years, until they were eclipsed by measurements over tests done in prairie grasslands in Kansas (1968) and northwestern Minnesota (1973).

"This was, up to its time, the most complete set of experiments done on that part of the atmosphere," says Don Lenschow, a senior scientist at the National Center for Atmospheric Reseach in Boulder, Colorado. "The value of O'Neill was that it showed you had to bring together a lot of different techniques, and you had to get auxiliary measurements in order to get the complete picture. It also allowed intercomparison of techniques measuring the same thing. People didn't know if they could trust a particular tool until it was compared with other instruments."

The findings had profound effects in fields beyond rocketry. University scientists used their data on wind currents to help farmers determine when to plant seeds for best yield, how fast surface moisture would evaporate, and how to use pesticides to maximum effect. Until the experiment, it was nearly impossible to improve farming techniques because farmers could never predict the winds; now scientists had a way to study the effect of air movement on crops, topsoil, and pesticides. They found, for example, that variations in soil temperature had an effect on the air movement above. And the moving air allowed agricultural pests to migrate for miles, a phenomenon that was not well understood until the tests.

The research helped improve weather forecasting techniques that the Air Force needed to become capable of flying in all kinds of weather. It also provided some surprises, including the finding that air above seemingly hot runways was actually cooler than air over grasslands. "They didn't want to believe it, but [the Air Force] gave up asking that all measurements of air density should be made about the runway," Lettau said.

As for Wernher Von Braun, who had long touted the virtues of such tests, he launched his first Redstone missile for the Army in 1953, four years before the O'Neill results were published. "It's one part of a bigger picture of understanding the atmosphere," says Michael Neufeld, a curator of space history at the National Air and Space Museum and the author of *Von Braun: Dreamer of Space, Engineer of War*. "It's useful, but so is a lot of other data you need if you're going to have a ballistic missile program. You need data on forces and weather, wind conditions and guidance control, for the whole column of air up to space."

Ryan's family sold the old field more than a decade ago. Today, there's little evidence that half a century ago it bustled with activity, with towers and anemometers and scientists living and working. No historic plaque marks the site; there is only irrigation equipment and grazing cattle. The one constant is the steady southerly breeze that still bends the prairie grass in the free world's flattest land.

Lettau (left) was cautious and reserved, while Loeser was brash and outspoken. Lettau went on to teach for 23 years at the University of Wisconsin at Madison, and won the American Meteorological Society's highest award in 1974.

COURTESY THE LETTAU FAMILY

Can This P-38

THE AUTHOR CAME HOME FROM WORLD WAR II. HIS AIRPLANE DIDN'T.

ON JUNE 27, 1944, THE U.S. 5TH ARMY HAD THE GERMANS in northern Italy on the run. That day, Army Air Forces First Lieutenant David Toomey, a pilot for the 3rd Photo-Reconnaissance Group, took off from an airfield at Tarquinia, 50 miles north of Rome, to photograph German fortifications along the northern perimeter of the Arno River valley, from Florence to Pisa. It was his second mission over the territory in a week. Toomey flew a Lockheed F-4 named Duckypoo, *the crew chief's pet name for his wife. The F-4 was a photo-reconnaissance version of the P-38 Lightning. To get good tactical photos, pilots had to fly the airplane low, and to keep from being shot down, they had to fly it fast. His camera was mounted on the right side of the fuselage, so to photograph the northern area of the valley, Toomey would have to fly west at 1,500 feet. His approach took him north along the coast, then inland just south of the Arno. He'd head east 50 miles to Florence, all at treetop level to avoid German radar, pull a U-turn, and come back along the valley to Pisa. That was the plan, anyway.*

Today, Toomey lives on Camano Island, Washington, and the P-38 he flew that day lies on the floor of the Tyrrhenian Sea, a few miles off Italy's coast. Hoping to find someone to confirm its location and finance its recovery, he and his colleagues have knocked on doors from Washington, D.C., to Washington state. The National Geographic Society was interested, but later decided not to pursue a project. Representatives of the Flying Heritage Collection, Paul Allen's museum in Everett, Washington, said that Allen purchases only airplanes that fly. Kermit Weeks, owner of Fantasy of Flight, a collection of flying historic airplanes in Polk City, Florida, told Toomey he already has a P-38. Even The International Group for Historic Aircraft Recovery declined. "They told me I'd best let Duckypoo *rest in peace," he says.*

The following is adapted from Toomey's typewritten memoir, Tall Tales and Vapor Trails.

THE DAY WAS PLEASANT but windy and slightly overcast. I took off at 0830 and headed *Duckypoo* out to sea and up the coast. Although *Duckypoo* was our oldest airplane, she was our fastest—an old P-38F that had been stripped down and equipped with a pair of more powerful Allison V-1710 turbo-supercharged engines, each of which churned out more than 1,400 horsepower. Speed, and the ability to fly at both low and high altitudes, made the P-38 a natural for photo-recon. Fighters, as they say, win battles; recons win wars. General Mark Clark, commander of the U.S. 5th Army, wanted our latest photos on his desk every morning at 0600.

In the F-4, we flew mostly two types of missions: mapping runs and pinpoint runs. In mapping runs we flew back and forth at 25,000 feet, photographing an area of 400 or 500 square miles. Our cameras were loaded with 180 feet of 12-inch-wide film, which meant we could make a total of 180 exposures. Each exposure covered an area of nine to 16 square miles and provided amazing detail.

On pinpoint runs, we flew to an isolated point of interest, such as a bridge, tunnel, or highway intersection. These missions required precise navigation to identify the target, which we did by correlating rivers, railroads, and towns with what we had on the map. Then it simply required three or four good exposures of the target—at least two were needed to produce the third dimension.

Today's mission, though, was the rare and voluntary third type: a dicer, from the word "dicey," which our British friends used for "risky." It was low and fast and left no room for error. It often put you face to face with the enemy.

I had transferred to the P-38 just six months earlier, from the copilot seat in the lumbering B-17 bomber. My love affair with the P-38 had begun at age 17, when I spent the summer of 1940 living with my grandmother in Portland, Oregon, cutting grass

ALL PHOTOS COURTESY DAVID F. TOOMEY

Be Saved?

BY DAVID F. TOOMEY

No. 174 "Duckypoo" which I was flying when shot down off the coast at Cecina, Italy, June 27, 1944.

In 2000, the Tuscan hills (below), with the village of Cecina on the shoreline, looked inviting from the seas where David Toomey had years earlier ditched his P-38 (left, with crew chief Red Hallerman at left, and a crewman). In June 1944, the German army was hunting for Toomey in those hills.

For Toomey (right) survival in the F-4, a P-38 modified for photo-recon, depended on speed. Once he got shot down, Toomey depended on a life preserver for a day, then snuck inland from the beach (below) in search of the Italian partisans.

The beach where I washed ashore after some 10 to 12 hours in the Tyrrhenian Sea. My plane sank about three miles out.

Speed was our only defense. The P-38 could generally outrun any of the Germans' airplanes, in both a climb and a dive. Bottom line: The most survivable photo-recon pilot was the one who was the most scared.

and brush for the city. On my days off, I went to the Portland Army Air Base to watch the airplanes take off and land. A squadron of P-38s was stationed there, I believe flying submarine patrol over the mouth of the Columbia River. As the airplanes returned to their base and "peeled up" for their landings, they were poetry in motion. I became fascinated by their sleek, twin-boom profiles and their graceful performance. Someday, I vowed, I was going to fly a P-38.

Four years later, here I was, flying the sleek Lockheed. On my first solo flight, in January 1944, I had left the ground at 100 mph, but as I retracted the landing gear, the airplane seemed to jump out from under me. I went from 100 to 250 mph so fast I couldn't believe it. I started climbing, and as soon as I got my coolant controls set I nearly fell over—my altimeter said 10,000 feet. Even when I slowed the airplane down I was going 250 mph. Most of the time my airspeed was around 300. (Imagine going a mile in 12 seconds, and you can understand 300 mph.) I saw 350 several times, and in short dives, I even reached 400.

Speed was our only defense. The P-38 could generally outrun any of the Germans' airplanes, in both a shallow climb or a dive. One day a group of Messerschmitt Bf 109s jumped me, and I outran them to the coast. I think I made 500 mph, going downhill. But I hit serious turbulence, and thought the airplane was going to come apart. The main spar between the engine booms and the gondola popped a bunch of rivets. When I got back it was a wreck, and they junked the airplane. The crew chief told me (jokingly) that I'd pushed on the throttle handles so hard I'd bent them. Bottom line: The most survivable photo-recon pilot was the one who was the most scared.

On this mission, I flew as close to the water as I could. To conserve fuel, I flew through the strait between the Isle of Elba and the mainland, rather than detouring around the island. I found the initial point I'd used before, then cut across the coast. The minute I crossed the frontlines, I'd always get a sick feeling in the pit of my stomach. In football we used to call it the "kickoff feeling." For me, it usually lasted up until I started my first run over the target. It was especially true for us in photo-recon, because we were always alone, with no wingman or squadron mates to help watch for flak or enemy fighters. You had to do it all—fly, navigate, survey, operate the camera—and never a

friendly face nearby to buck up your spirits.

A couple of miles later I crossed the main highway and approached a row of tall cottonwood trees. I hopped over them and dropped into a small meadow, which I recognized. At once I realized that something was wrong—something in the meadow had changed. A row of trees to my right hadn't been there before. Too late, I realized they were German heavy guns elevated vertically and camouflaged. The Germans must have seen me coming; they started shooting at me with everything they had. I even glimpsed one soldier firing at me with a pistol. It was a miracle I made it through the ambush. Something, either a bullet or shrapnel, came through the canopy and cut me over my right eye. I remember wiping blood from the small wound and looking stupidly at the hole in the plexiglass.

They started shooting at me with everything they had. I even glimpsed one soldier firing at me with a pistol. It was a miracle I made it through the ambush. Something came through the canopy and cut me over my right eye. I remember wiping blood from the wound and looking stupidly at the hole in the plexiglass.

The soldiers below and in front were all firing at me. I had no choice but to run their gauntlet. Suddenly one of my engines was on fire, and the cockpit began to fill with blinding smoke. I jettisoned the canopy. As soon as I could see, I banked the airplane sharply and, barely avoiding some trees, headed back toward the coast. Something hit the right engine, which lost power, knocking the airplane into a steeper bank. I threaded my way between groups of trees, fighting the controls, and struggled from one meadow to another. At last I crossed the beach and turned south toward Piombino Point and the Isle of Elba. I knew that my remaining engine wouldn't make it, so I started preparing to ditch the airplane close enough to Elba that I could swim ashore. Before long, however, I realized my remaining engine was failing—I'd never make it to Elba now. The coolant temperature was up against the peg, and oil pressure was gone. Slowly, *Duckypoo* was going down—nothing I did could stop her steady descent.

I was diagonally approaching long swells topped with whitecaps. Though not deliberate, it was the best thing that could have happened: I was making a classic ditching approach to a rough sea. I watched, spellbound, as the whitecaps came closer. In desperation, I kept pulling back on the controls, trying to hold the airplane off as long as possible. *Duckypoo* started skipping from wave to wave. After about the sixth or seventh one, she plowed into a swell and stood on her nose. The crash was surprisingly gentle but sudden, and I was still fumbling with my seatbelt and parachute harness when I went under with the airplane. I finally was able to kick free and leave the cockpit, and immediately pulled both lanyards on my Mae West. The life jacket inflated. After what seemed an eternity, I popped to the surface.

It was about 10 a.m.—my old hack watch quit as soon as it got wet. The sudden silence was eerie; the only sound was the wind and the waves. The minutes turned into an hour or so, and I began to realize that nobody had seen me go down. I could see the beach, maybe three miles away. But a slanting wind was keeping me out at sea. I tried to swim. It was hard to do in the Mae West and heavy G.I. shoes. I tried to pull off the shoes but couldn't because my legs had begun to cramp. Soon I could move only my arms, and only in a feeble paddle.

Hours passed. As each wave broke over my head, I began to struggle to keep from drowning. Occasionally I vomited some of the water I swallowed. I remember hearing airplanes, and watched a group of fighter-bombers attacking targets on the coast. Eventually, the wind subsided a bit, and began to blow toward the northeast. Over the course of several more hours, the wind pushed me slowly toward the beach. I began to hear waves breaking onto the sand, so I tried again to paddle.

By late afternoon, I had drifted into the breakers, where my progress became agonizingly slow. I half-expected someone to walk onto the beach and pull me ashore. At this point, I didn't care who it was, German or otherwise—I was totally exhausted. At last, a big wave washed me up on the sand. I was cramped up and face-down, unable to move any part

Toomey poses in front of a photo-recon version of a P-38J, which Lockheed introduced in August 1943. He got permission to name this aircraft *Nola Ruth* for his fiancée at the time, now his wife of 65 years.

of my body, not even my head. Waves continued to wash over me, but slowly the tide retreated. I tried to move farther up on the beach, but nothing wanted to work—not my arms, not my legs. Eventually, I was able to lift my head, and got my hands and then my arms to move. Finally, I pushed myself onto dry sand.

I remember how warm the sun and sand felt, then nothing more—I must have passed out. I'd been in the water at least ten hours.

By late afternoon, I had drifted into the breakers, where my progress became agonizingly slow. I half-expected someone to walk onto the beach and pull me ashore. At this point I didn't care who it was, German or otherwise—I was totally exhausted.

When I came to, the sun was down on the horizon. I stumbled up the beach toward some brush, and got caught in a barbed-wire entanglement. It snagged my clothes and tore a deep cut in the palm of my left hand. If there were mines, they were buried deep, because I didn't trip any. At the first brush pile, I took off my Mae West and buried it. Then I climbed up the six-foot bank and into the deepest brush I could find. The Germans hadn't found me yet, and I wasn't going to make their job any easier.

In the brush I found a patch of sunlight and pulled off my socks to dry them. I took out my escape kit and assessed my situation. The kit was a six-inch-square, rubberized-canvas pouch that we carried on every flight. Each kit was numbered. Pilots had to sign them out for each mission. I found a large silk map of Italy, an Italian/English dictionary, a short hacksaw blade, and a small compass with a dot pointing north. Except for the hacksaw, I would use every item to make my escape, especially the compass.

I was some 50 miles behind German lines. To make my escape I planned to walk east, deep into the mountains, and turn myself over to the Italian partisans, or resistance fighters. Ever since September 8, 1943, the date of the Italian armistice with the Allies, these *partigiani* had become a problem for the Germans and the Fascists. The brutality of the Germans toward villagers they suspected of resistance only bolstered the resolve of the *partigiani*. The Germans' horrific massacre of 5,000 Italian soldiers who had surrendered in Greece, just after the armistice, was among the first of many atrocities, including more than 400 massacres of civilians, that proved to the Italians they couldn't trust the Germans.

Still, we'd been told that the cities along the coast were likely Fascist, and that those Italians wouldn't hesitate to turn us over to the Germans, who offered rewards for Allied aviators. Years later, during my first trip back to the area, I learned from former partisans that the Germans had been looking for me, and even offered a reward for my capture. They and the Italians thought I'd crash-landed on the coast; they hadn't known I'd ditched at sea.

I curled up in the brush and went to sleep. When I awoke it was dark. Time to move out. I removed my pilot's wings and all insignia except my first lieu-

In World War II Italy, an M.P. stands at an ornamental gateway, which Toomey recalls from his first night on the run. The landmark later helped Gary Peters, Toomey, and Bill Peters (left to right) find where Toomey had come ashore.

tenant's bar and buried them. All I would need if I was captured would be proof of rank.

I had moved only a short distance when I encountered a massive complex of trenches, pill boxes, machine gun nests, and earthworks. Oddly, the place was deserted. I learned later that the Germans had built these defenses in anticipation of an Allied coastal invasion and beachhead, similar to that at Anzio. It must have taken me half an hour to work my way through it all.

On the other side I found myself in meadows surrounded by trees. I came to a creek that was pretty deep, so I followed along the bank until I found a narrow masonry bridge. I figured this must be the Cecina River; if so, I was on course into the mountains.

About then, a full moon started to come up. This made it easier to see the terrain but forced me to stop frequently. I had to wait to cross each meadow until a cloud covered the moon, affording me some invisibility. It slowed my progress, but I had little choice.

I came to a double railroad grade, and climbed over it into a patch of woods. Approaching an asphalt road bathed in moonlight, I hunkered down to wait for a cloud. Suddenly I heard footsteps and voices coming from up the road. I buried myself in the brush. With my face covered, I couldn't see anything, but the sound of hobnail boots told me they were probably German. I held my breath and remained frozen....

A P-38J-5-LO (foreground), a late Lightning variant, flies with an F-5, a later photo-recon version of the P-38. Only a handful of P-38s are flying today. *Duckypoo* may one day join them, if not in the air, then perhaps on the ground.

TOOMEY EVENTUALLY FELL IN WITH THE ITALIAN PARTISANS. They hid him, and kept him constantly on the move, rarely letting him stay with one group for more than a few hours. They ate squash blossoms, cabbages, onions, raw eggs, and very green apples. After four days, the Americans overtook the area, and Toomey returned to his unit and resumed flying.

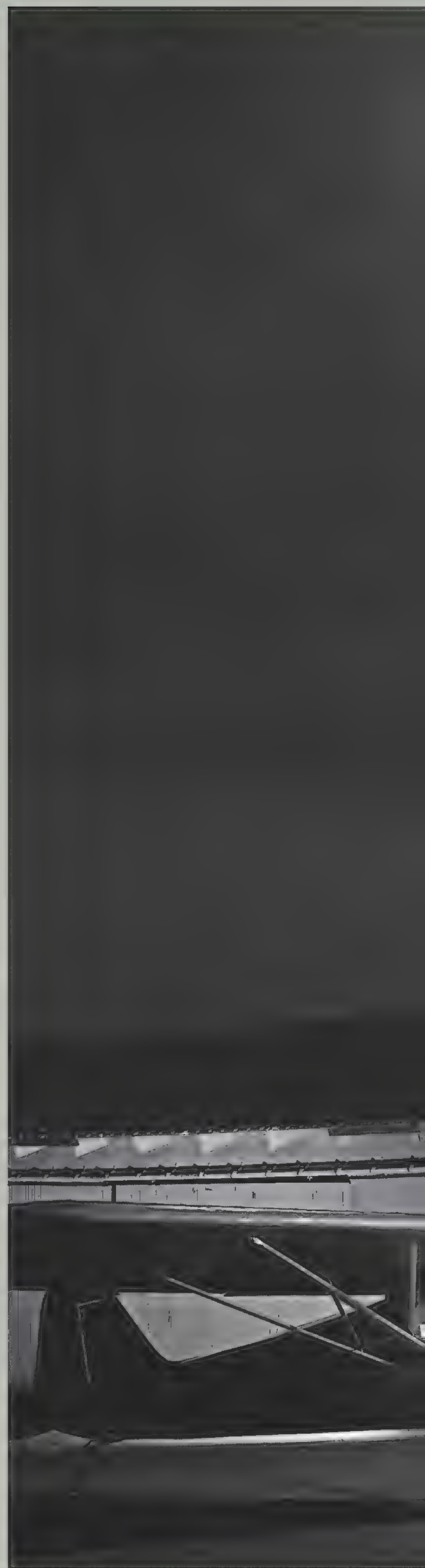
In 1976, he traveled back to the region and visited Guardistallo, a village he recalled from his time there. He was warmly received by the people, who showed him a bronze plaque bearing the names of 68 villagers whom the Germans had rounded up and machine-gunned on June 29, 1944, in reprisal for hiding Toomey and other American pilots. Twelve of the victims had been partisans, while the rest were innocent men, women, and children. "I feel that the price paid by the Italian people was far more significant than my modest contributions to World War II," Toomey says today. "I still find it incomprehensible that the German soldiers, presumed human beings, could sink to such levels of moral depravity."

In July 2000, Toomey returned again, this time with professional divers Bill and Gary Peters. The Peters brothers had heard Toomey's story and decided to fund a preliminary search for the airplane. In Cecina, the trio met an Italian diver who informed them of six wrecks off the coast, all charted with LORAN coordinates by the Italian government to help fishermen avoid the craft with their nets. He had personally dived on five of them, but none was a P-38. He introduced them to a dive boat captain who took them out to the one charted wreck that remains unidentified. It lies almost four miles offshore in 116 feet of water. The sea had been rough all week, and the brothers were able to dive only once. When they reached the bottom, visibility was three to four feet, and they ran low on air before they could find the wreck. But based on their research, including triangulations of Toomey's flight path with where he washed up on the beach, and his personal recollections, all feel confident that this wreck is Duckypoo, *and share a hope that an aircraft collector will step forward to help tell the final chapter of Toomey's tale.*

Sightings

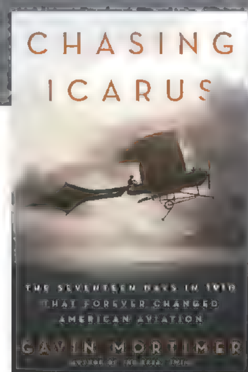
PICTURES WORTH A SECOND LOOK

THE AIRFIELD AND CAMERA BOTH are from another era. Galt Airport, founded by Arthur Galt in 1950 in Greenwood, Illinois, lies in uncontrolled airspace, where air traffic control is unnecessary. So "Uncontrolled Airspace" became the title of a photo exhibit by Steve Mark, running through October 31, 2009, at the Experimental Aircraft Association's museum in Oshkosh, Wisconsin. "The project started as an assignment for a photography class," says Mark, "but quickly expanded to a year-long, 47-weekend labor of love." In 2008, Mark captured daily life at the airport, using a Graphic View camera and four- by five-inch film typical of studio equipment in the 1940s. Counterclockwise from left: New pilot Bruce Schottland wipes bugs off a Cessna 150, Mike Kryscha poses on the runway with a model glider (affixed to a hidden ladder), and Bill Miles perches in his Piper Cub as Mike Lobaito works late on a summer night. To see more of Mark's photos, visit *www.uncontrolledairspace.info.*



Those Magnificent Men in Their Flying Machines

Seventeen days in October 1910 saw the world's best aviators trying to set records and win races in all sorts of aerial contraptions.



Chasing Icarus: The Seventeen Days in 1910 That Forever Changed American Aviation

by Gavin Mortimer. Walker Publishing, 2009. 305 pp., $26.

CHASING ICARUS offers a detailed account of the aeronautical excitement that filled the last two weeks of October 1910. The headlines began on October 14, when English aviator Claude Grahame-White landed his Farman biplane next to the White House and greeted President William Howard Taft. The next day, Walter Wellman, a 52-year-old Ohio newspaperman and adventurer, accompanied by five crewmen, took off in the airship *America* from Atlantic City, New Jersey, bound for Europe. Two days later, on October 17,

Spectators at the Belmont Park air meet (top, left and right) saw Edmond Audemars (above, underneath wing) fly – briefly – in the Demoiselle. Above, left: Melvin Vaniman and Kiddo, a cat, aboard the SS *Trent* after abandoning the airship *America* at sea.

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10 balloons lifted off from St. Louis, Missouri, in the fifth annual James Gordon Bennett balloon race. On October 22, the world's leading aviators gathered at New York's Belmont race course for an air meet.

> **These two weeks were filled with tension. Had Augustus Post and Allan Hawley flown to their deaths in the Canadian wilds?**

These two weeks were filled with tension. Would Wellman and his crew cross the Atlantic? Would they even survive? Had Augustus Post and Allan Hawley, the favored American team in the balloon competition, flown to their deaths in the Canadian wilds, or would they emerge from the North woods victorious? Readers will find all of the drama they can handle, along with engaging biographical portraits of the always daring, sometimes foolish aeronautical pioneers involved.

It is a bit of a shame, however, that the author allows an anti-Wright bias to peek through an otherwise well-balanced account. While it is reasonable to note the resentment expressed by aviators and aircraft builders who were the potential targets of the Wrights' patent infringement suits, it is scarcely reasonable for Mortimer to charge the inventors of the airplane with "paranoiac greed." In addition, he writes: "The younger of the two brothers [Orville] had never before flown in the east—discounting the brief exhibition he had performed for the military at Ft. Myer, Virginia in 1908."

That "brief exhibition" included 20 flights, during which Orville set eight world records. He returned to Fort Myer for 36 more flights in 1909, during which time he completed all of the requirements for the sale of the first airplane to the U.S. Army. He then traveled to Germany, where he made a total of 64 flights. Early in 1910, before the Belmont meet, he completed 250 to 300 flights in Montgomery, Alabama, and Dayton, Ohio. Orville was not only one of the two inventors of the airplane, at the time of the Belmont meet he was also perhaps the world's most experienced aviator. Nevertheless, Mortimer has given us a dramatic and valuable account of the early days of aviation—a book that is genuinely hard to put down.

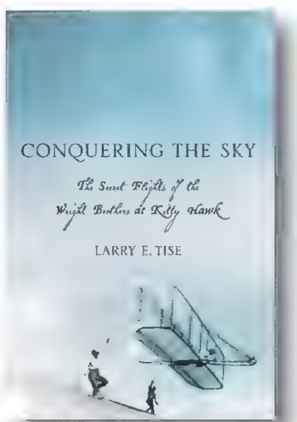
TOM CROUCH, A SENIOR AERONAUTICS CURATOR AT THE NATIONAL AIR AND SPACE MUSEUM, IS A HISTORIAN OF THE WRIGHT BROTHERS.

Conquering the Sky: The Secret Flights of the Wright Brothers at Kitty Hawk

by Larry E. Tise. Palgrave Macmillan, 2009. 250 pp., $25.

THE SUBTITLE refers to a week in May 1908 the Wright brothers spent making test flights at Kitty Hawk, North Carolina, but the book itself is more a minutely detailed account of the Wrights' relationship with the press during that time.

Though the brothers had invited reporters to witness one 1904 flight, when it failed, the newspapers left the brothers alone. As did the U.S. government (whose attention the brothers wanted), burned by having spent six figures on Samuel Langley's 1903 Aerodrome, which, like nearly every other early flying machine, had steadfastly refused to fly. Finally, though, in 1907, the Wrights convinced France and the United States that they had indeed built a *Flyer* that could honestly, truly fly, even offering to demonstrate it—carrying a passenger—before the customer signed the check.



For the 1908 demonstrations, the brothers modified their successful 1905 machine, which had originally been built for a single pilot lying prone on the bottom wing. They now installed two seats and reconfigured the controls. Always cautious, they wanted to test the new configuration—away from prying eyes. That meant returning to remote Kitty Hawk, with its high winds and soft dunes. Once word got out, though, big-city newspapers assigned their best reporters to brave the sand, chiggers, and May heat in order to get the scoop.

Despite the Wrights' resolve to conduct their test flights in private, the reporters hid in the woods and watched. A photographer from *Collier's Weekly* even snapped a picture of the Wrights' biplane in flight.

When Wilbur departed for France to fly for government representatives, there would be no more hiding. In just one week's time, the photo in *Collier's* and stories in the *London Daily Mail* and the *New York Herald* pushed the pair out of anonymity and into global fame. "Wright Brothers' Success in the Air No Longer a Secret," trumpeted the *Herald*.

With the exception of *The Papers of Wilbur and Orville Wright*, edited by Marvin McFarland, most accounts of the Wrights gloss over those seven days in May with a couple of paragraphs. In the preface of this book, Larry Tise explains that after visiting Kitty Hawk as a child, he read up on the brothers, and couldn't understand why most of the books focused on the events leading up to the brothers' December 17, 1903 first flight. He says he hopes the book will fill at least one gap in the Wrights' story, and he succeeds—in excruciating detail. While *Conquering the Sky* is not useful as an introduction to the Wright brothers, for anyone fanatical about them, the book is a must.

PHIL SCOTT IS THE AUTHOR OF *SHOULDERS OF GIANTS: A HISTORY OF HUMAN FLIGHT TO 1919.*

A Hundred Feet Over Hell: Flying With the Men of the 220th Recon Airplane Company Over I Corps and the DMZ, Vietnam 1968-1969

by Jim Hooper. Zenith Press, 2009. 258 pp., $25.

DURING 1968 AND 1969, the author's brother, Bill, served in the U.S. Army flying a Cessna O-1 Bird Dog over the Demilitarized Zone, or DMZ, in Vietnam until he was seriously wounded while flying a mission. After a lengthy hospitalization and rehab, he returned home and told his brother Jim about his experiences and those of the men of the 220th Recon Airplane Company—the Catkillers. An established author and combat reporter, Jim Hooper began gathering documents, facts, and records while locating the men in his brother's unit. The book narrates the period from Bill Hooper's arrival in the unit as an FNG (a traditional GI vulgarity—one of many terms, some slang, some official, defined in the book's glossary) until the end of his final mission.

One note: Copy on the book's jacket states that the book often uses the men's "own words." The author re-creates long conversations enclosed in quotation marks, and skeptical readers will rightly question how, after time has passed, one can recall a lengthy exchange word for word. The technique, now a mainstream practice in non-fiction writing (although not one to be emulated), is untrustworthy. Look past that, though, and you're in for a helluva read.

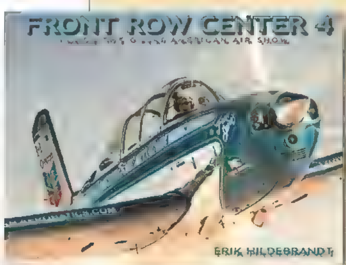
The DMZ abutted I Corps at the northern border of South Vietnam. Though this was U.S. Marine Corps country, an Army unit provided support for artillery adjustment, recon, and control of air strikes. In the rest of the theater, however, Army O-1 pilots did not act as FACs, or forward air controllers, for air strikes; the Army ran artillery, and the U.S. Air Force FACs ran air strikes. As an added attraction in I Corps, the battleship USS *New Jersey* maintained a constant vigil off the coast during 1968 and 1969 and could be called upon to add nine 16-inch guns to the almost continuous chorus of "Incoming."

Here is where some of the most hair-raising fights of the war erupted. The DMZ had been created by treaty to be a buffer zone between the north and south, but the north simply ignored the rules and occupied the entire area, using it as a storage site for supplying its forces in their forays south. Their allies equipped the North Vietnamese army with some bodacious anti-aircraft firepower—multi-barrel and radar-directed

>>> Highlights <<<

Front Row Center 4: Inside the Great American Air Show

by Erik Hildebrandt. Cleared Hot Media, 2009. 172 pp., $39.95.



Frequent contributor Erik Hildebrandt unveils his latest book documenting the airshow world. *Front Row Center 4*, based on photographs he took during last year's airshow season, features such performers as Michael Goulian, Jacquie B, and the Red Arrows.

From top to bottom: Chuck Aaron flying the Red Bull helicopter; the Collaborators, led by Sean D. Tucker; Julie Clark, flying her T-34 through streams of pyrotechnics.

automatic guns ranging up to 57-millimeter cannon. Because the O-1s lacked armor, the aircrew's only defenses were to fly very low over areas with thicker foliage, use the aircraft's light weight and excellent maneuverability to evade the gunners, and hope artillery or an air strike was on its way.

Hooper examines various combat encounters from many points of view to build detailed composite pictures of events. And he delves deeply into the emotions and bonds that held the unit together, recounting amusing after-hours high jinks, the grim humor of wartime, and the washing away of a day's stress in that universal solvent, alcohol.

The best thing about the book is that—conversational re-creations notwithstanding—every page rings true, and with very rare exception, names are named. Writing fearlessly and with an artfulness that few others have managed, Hooper has captured the ironies, the buccaneer's ethos, and the rhythms of men at war.

Thirty years ago, Robert Mason published *Chickenhawk*, a classic personal account of Vietnam helicopter operations that is still as potent as a satchel charge. I'd rank *A Hundred Feet Over Hell* right up there with it.

GEORGE C. LARSON SERVED AS A MACV (MILITARY ASSISTANCE COMMAND, VIETNAM) ADVISOR IN II CORPS AND FLEW MANY HOURS IN THE BACK SEAT OF AN O-1 IN QUANG DUC PROVINCE.

>>> **Excerpt** <<<

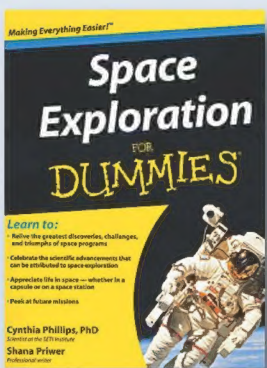
Space Exploration for Dummies

by Cynthia Phillips and Shana Priwer. Wiley, 2009. 364 pp., $19.99.

The following excerpt is from a chapter entitled "Ten Ways Space Travel Isn't Like Television or the Movies."

SPACE ISN'T NOISY

From *Star Wars* to the arcade down the street, most popular portrayals of space depict it as a very noisy place. Between the whooshing of starships and the sounds of laser guns shooting audibly (directly into space, mind you), space appears about as quiet as a New York City street during rush hour. Explosions are fiery, loud events, and one spaceship crashing into another results in audible, audience-pleasing sounds.



The fundamental problem with space noise is that sound waves don't transmit in a vacuum. A *vacuum* is defined as matter-free space, or space with a gaseous pressure significantly lower than its atmospheric pressure. The parts of outer space that lie between planets and stars (in other words, most of it) are considered a vacuum. Sound waves are mechanical vibrations that require a molecular substance, such as water or air, to travel through. Vacuums are devoid of those molecules, so there's no way sound can transmit through them.

The classic 1968 movie *2001: A Space Odyssey* got this one right. During the scenes in which an astronaut travels outside his ship in a spacesuit, all you can hear is his breathing. Unfortunately for scientific accuracy, audiences find silence boring. They much prefer special effects, so expect on-screen spaceships to continue whooshing by.

Excerpt from *Space Exploration For Dummies* by Cynthia Phillips and Shana Priwer, provided with permission by John Wiley & Sons. Available wherever books are sold.

Credits

Canadian Helicopter Force, Afghanistan. Jonathan Knaul wrote "Memories of Kosovo" for the Dec. 2000/Jan. 2001 issue. The two Boy Scouts mentioned in that story came to Canada under his initiative and now work in the Canadian aviation industry.

Blown Away. Ken Scott builds airplanes in a hangar beneath his wife's violin studio and flies from the grass airstrip in his back yard.

Now You See It, Now You Don't. Damond Benningfield is a freelance science and technology writer and radio producer in Austin, Texas.

Sweet 17. James Wynbrandt is a multi-engine instrument-rated pilot who flies a Mooney M20K.

The Shining. Tim Wright is a writer and photographer living in Richmond, Virginia.

The Bear Is Back. Preston Lerner wrote about U.S. Navy E-2 Hawkeyes in the June/July 2008 issue.

How the Spaceship Got Its Shape. Andrew Chaikin's latest book is *Voices From the Moon: Apollo Astronauts Describe Their Lunar Experiences* (Studio, 2009).

The Book of Hours. Tom LeCompte is a pilot and freelance writer who lives near Boston.

Prairie Wind. Dave Manoucheri, who grew up in O'Neill, Nebraska, after the atmospheric studies, manages a freelance television investigative unit in El Dorado Hills, California.

Can This P-38 Be Saved? Despite his harrowing World War II experiences, David Toomey is still an ardent fan of aviation.

Forecast

IN THE WINGS AND ON THE WEB...

The Only *Real* Warplanes
New Yorker writer and illustrator Bruce McCall looks back on his youthful obsession with piston power.

Thanks for the Memories
When Bob Hope took his USO show on the road, he didn't do it alone. Meet a few of the pilots and crew members who helped make the shows a success.

Rodney Dangerfield of Attack Aircraft
The Legends of Vietnam series returns with the diminutive A-37. Short on looks and long on talent, the SuperTweet flew 165,000 combat sorties and still gets no respect.

The Last of Its Kind
After an eight-year restoration, an antique Pitcairn takes flight.

DON PARSONS

Jack Tiffany (right) restored the Pitcairn autogyro; Andrew King flies it.

AT WWW.AIRSPACEMAG.COM:

CHECK OUT "Snapshot" for a gallery of space and aviation photos, including an F-22 going supersonic, the specially designed Red Bull BO-105 CBS helicopter, and a supernova remnant. And keep informed of the events and anniversaries in aviation and spaceflight by tuning in to our blog, *The Daily Planet*.

Moments & Milestones

PRODUCED IN COOPERATION WITH THE NATIONAL AERONAUTIC ASSOCIATION

The American Way

EVERY YEAR, at a banquet that draws many luminaries from the aerospace industry, the National Aeronautic Association awards the Wright Brothers Memorial Trophy to an individual for "significant public service of enduring value to aviation in the United States." Last year, the award went to Norman R. Augustine, former chief executive of Martin Marietta and later, Lockheed Martin. The criteria for the trophy stipulate that it go to a living American. That ensures a live speaker at the banquet.

Notice, though, that the rule says "American," not "American-born." And when Gerhard Neumann received the Wright Trophy in 1993, few attending the affair may have been aware that Neumann was an American only because of an act of Congress.

Neumann was born in 1917 in Germany; with the encouragement of his father, he left school at a young age to become an apprentice mechanic under the tutelage of a stern and exacting *Meister*, who warned him at the outset never to expect thanks or praise in any form.

He spent that part of his formative years under automobiles, mud dripping into his eyes and dirty grease forming permanent black arcs under his fingernails. Throughout his life, he credited working with his hands and getting a feeling for machinery for his brilliant intuition and ability to visualize solutions.

Neumann was a natural, but he also benefitted from chance encounters with the right people. W. Langhorne Bond hired him to come to China and work for the Chinese National Aviation Corporation, but by the time he arrived, the CNAC had vanished. Luckily, Colonel Claire Chennault was there and recognized his promise; he made him a master sergeant and put him to work maintaining the Curtiss P-40 Warhawks that the Flying Tigers operated in China during the early days of World War II.

After being sent to Washington to report to the government on intelligence matters, he began looking for work but found his alien status an obstacle.

With the help of influential supporters, Congress fashioned a special piece of legislation granting him citizenship, and President Harry Truman signed it in 1945. Neumann was finally free to take a job offer he'd gotten from Douglas Aircraft before the war ended.

Neumann later went to work designing jet engines for General Electric. During his 32 years there, he made his greatest contributions, including the ones that earned him the trophy. When GE execs tasked him with designing a small, lightweight engine capable of driving a future fighter beyond Mach 2, he conjured the J79, a miraculous turbojet that would go on to power tens of thousands of aircraft. At the heart of that engine was a Neumann innovation: the variable stator. Stators redirect the airflow moving rearward in a jet engine's compressor so that at each stage the air meets the rotating blades at an optimum angle. Fixed stators were a compromise, like an airplane's fixed-pitch propeller. Neumann's stators could be rotated at their roots to change the angle at which they greeted the incoming air.

Later, Neumann was credited with instrumental contributions to the large high-bypass fanjets that have come to power jet transports of all kinds. GE's large TF39 fans powered the first Lockheed C-5 Galaxy military transports in 1964, and the CF6 engine still powers Boeing 747s and other wide-bodies.

Any question of whether the Wright Trophy could be given to someone who wasn't U.S.-born had been settled in 1954, when the NAA gave it to Theodore von Kármán, an aerodynamicist born in Hungary. Neumann got his trophy in 1993, just four years before he died.

GEORGE C. LARSON, MEMBER, NAA

With highly trained engineers coming to the United States from abroad, chances are good that we'll see more naturalized citizens in line for the Wright Trophy.

ERIC LONG

VISIT THE NAA WEB SITE AT *WWW.NAA.AERO* OR CALL (800) 644-9777.